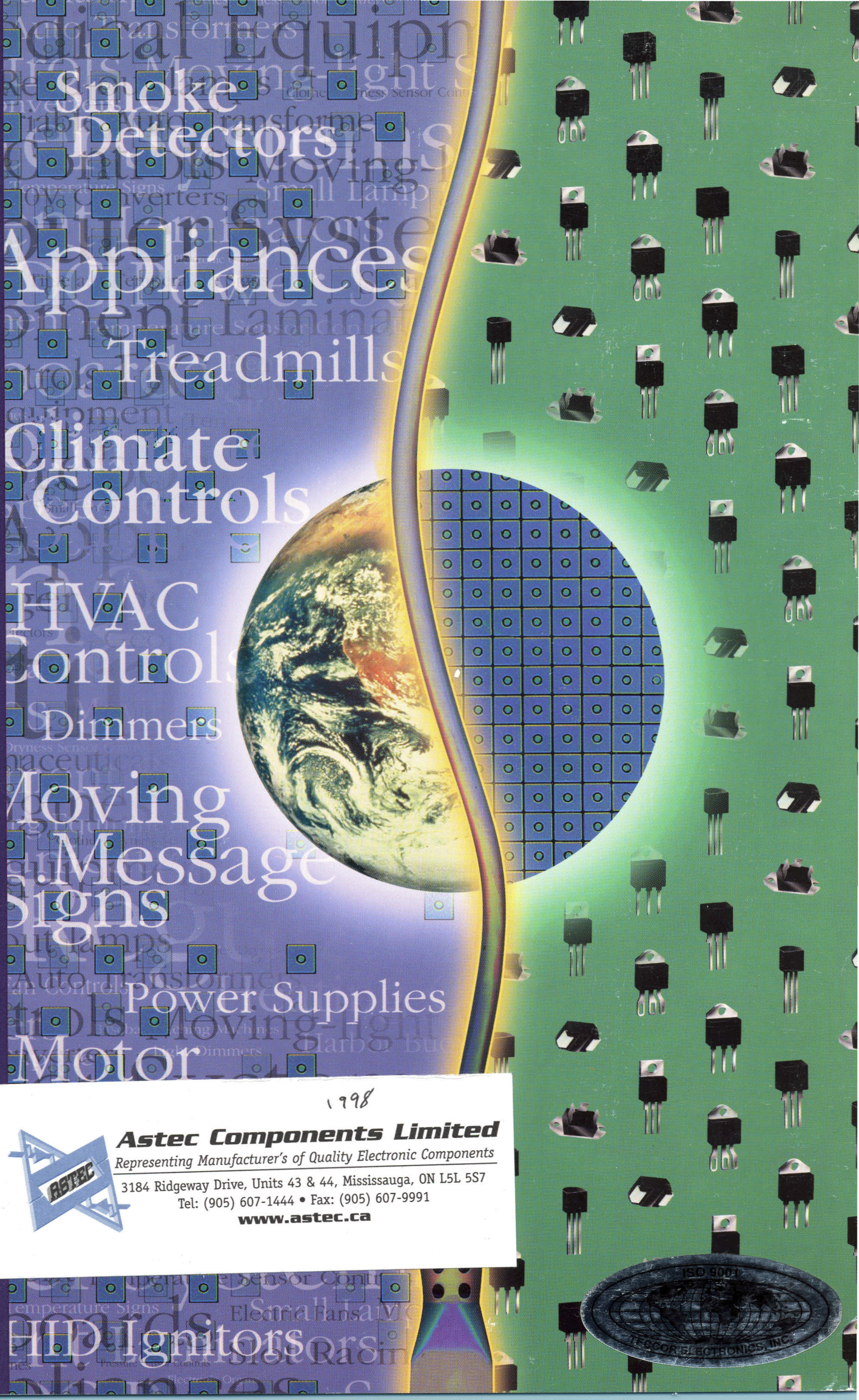
TECCOR
ELECTRONICS, INC.

THYRISTOR PRODUCT CATALOG



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SIEBE®
A Siebe Group Company

Thyristor Product Catalog

By

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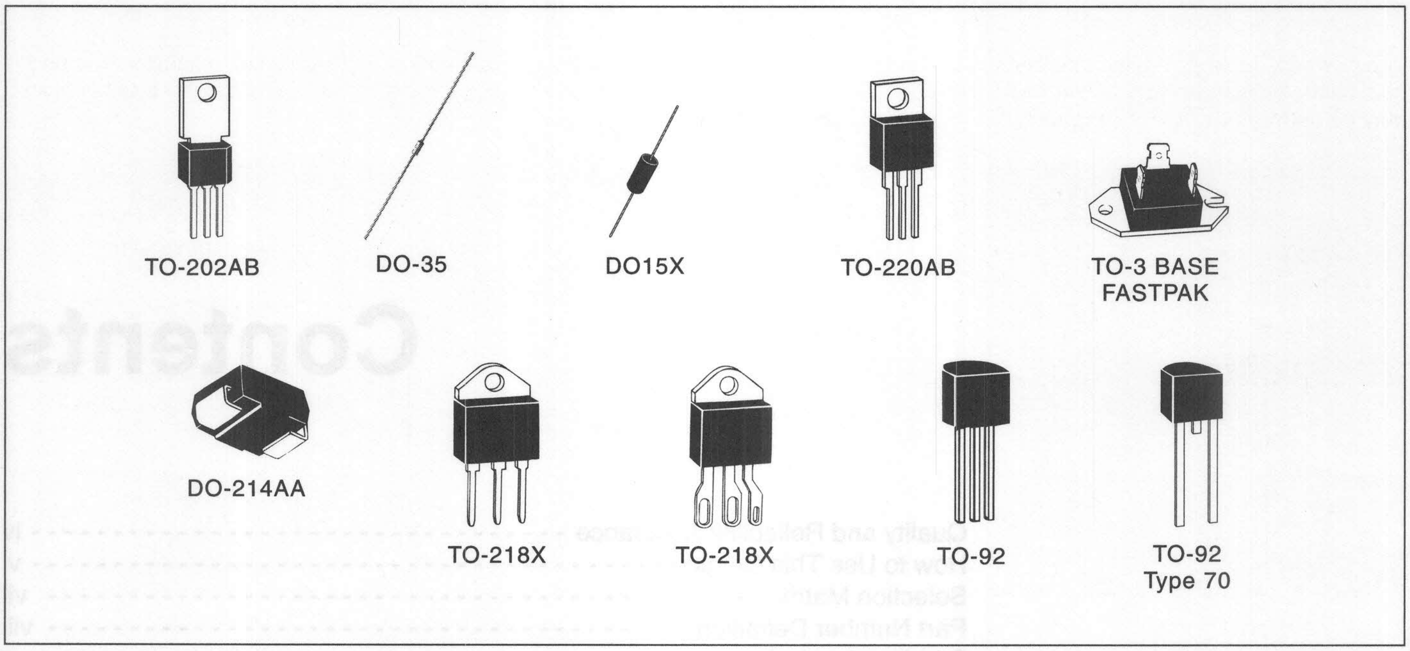


Quality Assurance Overview

Incoming Material Quality

Teccor "Vendor Analysis" programs provide stringent requirements before components are delivered to Teccor. In addition, purchased materials are rigidly tested at incoming inspection for specification compliance prior to being accepted for use.

Process Controls

From silicon slice input through final testing, we utilize statistical methods to control all critical processes. Process audits and lot inspections are performed routinely at all stages of the manufacturing cycle.

Parametric Testing

All devices are 100% computer tested for their specific electrical characteristics at critical processing points.

Final Inspection

Each completed manufacturing lot is sampled and tested for compliance with electrical and mechanical requirements.

Reliability Testing

Random samples are taken from various product families for ongoing reliability test.

Finished Goods Inspection

Product assurance inspection is performed immediately prior to shipping.

Quality And Reliability Assurance

Teccor is committed to advancing quality from narrowly defined technical issues to a total management focus. This management direction at Teccor provides quality and reliability in our products that is second to none.

The design and production of Teccor devices is a demanding and challenging task. Disciplined skills coupled with advanced computer aided design, production techniques and test equipment are essential elements in Teccor's ability to meet your demands for the very highest levels of quality.

All products must first undergo rigid quality design reviews and pass extensive environmental life testing. Teccor utilizes Statistical Process Control (SPC) with associated control charts throughout to monitor the manufacturing processes.

Only those products which pass tests designed to assure Teccor's high quality and reliability standards, while economically satisfying customer requirements, are approved for shipment. All new products and materials must receive approval of QRA prior to being released to production.

The combination of reliability testing, process controls and lot tracking assures the quality and reliability of Teccor's devices. Since even the best control systems cannot overcome measurement limitations, Teccor designs and manufactures its own computerized test equipment.

Teccor's Reliability Engineering Group conducts ongoing product reliability testing to further confirm the design and manufacturing parameters. The following table describes some of these tests.

Reliability Stress Tests

The following table contains brief descriptions of the reliability tests commonly used in evaluating Teccor product reliability on a periodic basis. These tests are applied across product lines depending on product availability and test equipment capacities. Other tests may be performed when appropriate.

Test Type	Typical Conditions	Test Description	Standards
High Temperature AC Blocking	T_A = 100°C to 150°C, Bias @ 100% Rated V_{drm}, t = 24 to 1000 hrs	To evaluate the reliability of product under bias conditions and elevated temperature	MIL-STD-750, M-1040
High Temperature Storage Life	T_A = 150°C, t = 250 to 1000 hrs	To evaluate the effects on devices after long periods of storage at high temperature	MIL-STD-750, M-1031
Temperature and Humidity Bias Life	T_A = 85°C to 95°C, rh = 85% to 95%, Bias @ 80% Rated V_{drm}, t = 168 to 1008 hrs	To evaluate the reliability of non-hermetic packaged devices in humid environments	EIA / JEDEC, JESD22-A101
Temperature Cycle [Air to Air]	T_A = -65°C to 150°C, cycles = 10 to 100	To evaluate the device's ability to withstand the exposure to extreme temperatures and the forces of TCE during transitions between temperatures	MIL-STD-750, M-1051, EIA / JEDEC, JESD22-A104
Thermal Shock [Liquid to Liquid]	T_A = 0°C to 100°C, t_{txfr} = ≤ 10s, cycled = 10 to 20	To evaluate the device's ability to withstand the sudden changes in temperature and exposure to extreme temperatures	MIL-STD-750, M-1056
Autoclave	T_A = 121°C, rh = 100%, P = 15psig, t = 24 to 168 hrs	An accelerated environmental test to evaluate the moisture resistance of plastic packages	EIA / JEDEC, JESD22-A102
Resistance to Solder Heat	T_A = 260°C, t = 10s	To evaluate the device's ability to withstand the temperatures as seen in wave soldering operations	MIL-STD-750, M-2031
Solderability	Steam aging = 1 to 8 hrs, T_{solder} = 245°C, Flux = R	To evaluate the solderability of device terminals after an extended period	MIL-STD-750, M-2026, ANSI-J-STD-002

Flammability Test

Test Description	Test	Comments
Flammability	UL 94V0	All epoxies used in Teccor encapsulated devices are recognized by Underwriters Laboratories.

How to Use This Catalog

This catalog shows Teccor's current standard product line. Due to the fact that new products and improvements are being made continually, it is advisable to contact the factory for the latest revisions if you do not find the component you need. Teccor also offers “special components” on large volume orders. Direct special requests to the factory. Teccor's catalog is designed for quick access to the desired product group. Data sheets for each product group are included with complete electrical specifications.

If product group is known ...

Refer directly to the appropriate product data sheet in this catalog. (See “Contents” on page vii.)

If type number is known ...

See “Cross Reference Guide” in this catalog for equivalent part number. When the Teccor part number is identified, see “Part Number Index” for the page number of the correct data sheet. Teccor part number definitions precede the index.

If the circuit requirement is known ...

See “Selection Chart” below for correct product type and referenced section in the catalog.

If current rating and/or package configuration is known ...

See See “Selection Matrix” on page vii.

For special components ...

Contact the Teccor Sales Department:

Phone: 972-580-7777
FAX: 972-550-1309

For package configuration information ...

See “Package Dimensions” and “Lead Form Dimensions” sections in this catalog.

For application information ...

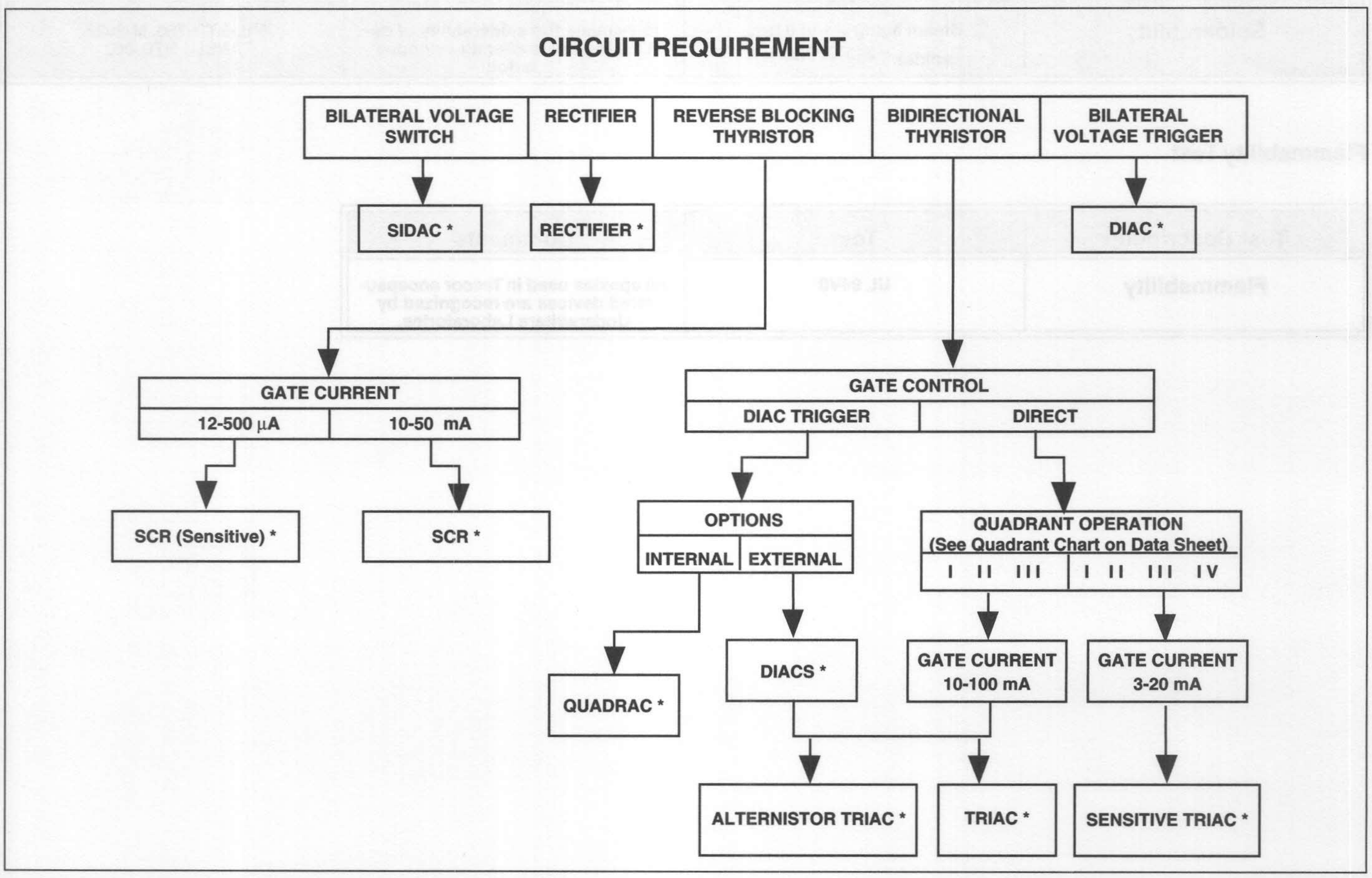
Refer directly to the appropriate application note in this catalog. (See catalog “Contents” on page -vii.) For additional application information and assistance, contact the factory or your local sales representative.

For additional copies of this catalog, prices, samples, sales or engineering assistance ...

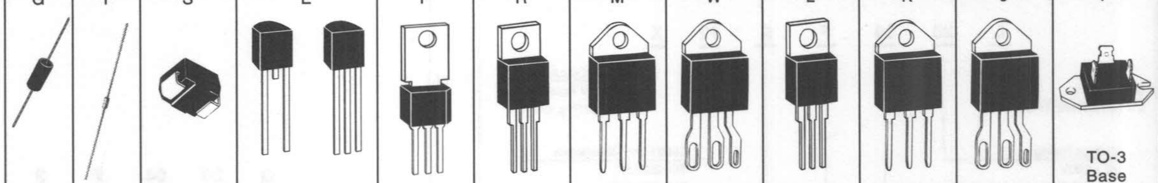
Contact the factory or your local distributor or representative office.

Website: www.teccor.com

Selection Chart



* See Product Data Sheet in this catalog for detailed information.



Product Type	Current (AMPS)					NON-ISOLATED Mounting Tab				ISOLATED Mounting Tab			
	Pkg.	G	Y	S	E	F	R	M	W	L	K	J	P
		DO-15	DO-35	DO-214AA	TO-92*	TO-202AB	TO-220AB	TO-218AC	TO-218X	TO-220AB	TO-218AC	TO-218X	TO-3 Base Fastpak
SENSITIVE TRIAC	0.8				✔								
	1.0				✔								
	4.0					✔	✔			✔			
	6.0									✔			
	8.0									✔			
TRIAC	0.8				✔								
	1.0				✔								
	4.0					✔				✔			
	6.0					✔	✔			✔			
	8.0					✔	✔			✔			
	10.0					✔	✔			✔			
	15.0						✔			✔			
	25.0						✔			✔			
QUADRAC	4.0									✔			
	6.0									✔			
	8.0									✔			
	10.0									✔			
	15.0									✔			
ALTERNISTOR	6.0						✔			✔			
	8.0						✔			✔			
	10.0						✔			✔			
	12.0						✔			✔			
	15.0						✔			✔			
	25.0						✔			✔	✔	✔	✔
	40.0										✔	✔	✔
SENSITIVE SCR	0.8				✔		✔						
	1.5				✔		✔						
	4.0					✔	✔						
	6.0					✔	✔			✔			
	8.0					✔	✔			✔			
	10.0					✔	✔			✔			
SCR	1.0				✔								
	6.0					✔				✔			
	8.0					✔	✔			✔			
	10.0					✔	✔			✔			
	12.0						✔						
	15.0									✔			
	16.0						✔						
	20.0									✔			
	25.0						✔			✔			
	35.0										✔	✔	
	40.0						✔						
	55.0						✔	✔	✔				
	65.0										✔	✔	
	70.0								✔				
RECTIFIER	15.0									✔			
	20.0									✔			
	25.0									✔			
DIAC			✔										
SIDAC		✔		✔	✔*	✔							

Note: All Sidacs in TO-92 package are two-leaded.

Part Number Definition

SENSITIVE TRIAC

L 20 04 F 5 12 X

Device Type
L = SENSITIVE TRIAC

Voltage Rating
20 = 200V
40 = 400V
60 = 600V

Current Rating
01 = 1.0 Amp
04 = 4.0 Amps
06 = 6.0 Amps
08 = 8.0 Amps
X8 = 0.8 Amp

Package Type
E = TO–92 . . . . (Isolated)
F = TO–202AB. . . . . (Non-Isolated)
L = TO–220AB . . . . (Isolated)

Gate Variations
3 = 3mA
5 = 5mA
6 = 5mA (Quad I, II, III)
10mA (Quad IV)
8 = 10mA (Quad I, II, III)
20mA (Quad IV)

Lead Form Dimensions
TO–202AB *
TO–220AB *
TO–92 *

Special Options
V=4000V Isolation
(TO-220 Pkg. Only)

* See "Lead Form Dimensions" section in this catalog for detailed information.

QUADRAC

Q 20 04 L T 52 X

Device Type
Q = QUADRAC

Voltage Rating
20 = 200V
40 = 400V
50 = 500V
60 = 600V

Current Rating
04 = 4.0 Amps
06 = 6.0 Amps
08 = 8.0 Amps
10 = 10.0 Amps
15 = 15.0 Amps

Package Type
L = TO–220AB (Isolated)

Gate Variation
T = Internal DIAC Trigger

Lead Form Dimensions
TO–220AB *

Special Options
V = 4000V Isolation
(TO–220 Pkg only)

* See "Lead Form Dimensions" section in this catalog for detailed information.

TRIAC and ALTERNISTOR

Q 20 04 F 3 1 X

Device Type
Q = TRIAC or
ALTERNISTOR

Voltage Rating
20 = 200V
40 = 400V
50 = 500V
60 = 600V
70 = 700V
80 = 800V

Current Rating
01 = 1.0 Amp
04 = 4.0 Amps
06 = 6.0 Amps
08 = 8.0 Amps
10 = 10.0 Amps
12 = 12.0 Amps
15 = 15.0 Amps
25 = 25.0 Amps
40 = 40.0 Amps

Package Type
E = TO–92 . . . . (Isolated)
F = TO–202AB. . . . . (Non-Isolated)
J = TO–218X . . . . (Isolated)
K = TO–218AC . . . . (Isolated)
L = TO–220AB. . . . . (Isolated)
P = FASTPAK . . . . (Isolated)
R = TO–220AB . . . . (Non-Isolated)
W = TO–218X . . . . (Non-Isolated)

Gate Variation
3 = 10mA (I II III)
4 = 25mA (I II III)
H4 = 35mA (I II III) **
5 = 50mA (I II III)
H5 = 50mA (I II III) **
6 = 80mA (I II III) **
7 = 100mA (I II III) **
None = 80mA (I II III) 25 Amp FASTPAK
None = 100mA (I II III) 40 Amp FASTPAK

** Note: Aternistor Device;
No Quadrant IV Operation

Lead Form Dimensions
TO-202AB *
TO-220AB *
TO-92 *
TO-218X *
TO-218AC *

Special Options
V = 4000V Isolation
(TO–220 Pkg only)

* See "Lead Form Dimensions" section in this catalog for detailed information.

SENSITIVE SCR

S 20 06 F S2 21 X

Device Type
S = SEN. SCR

Voltage Rating
05 = 50V
10 = 100V
20 = 200V
30 = 300V
40 = 400V
50 = 500V
60 = 600V

Current Rating
06 = 6.0 Amps
08 = 8.0 Amps
10 = 10.0 Amps

Package Type
F = TO–202AB . . . . (Non-Isolated)
L = TO–220AB. . . . . (Isolated)

Gate Variations
S1 = 50µA
S2 = 200µA
S3 = 500µA

Lead Form Dimensions
TO–202AB *
TO–220AB *

Special Options
V=4000V Isolated
(TO-220 Pkg.Only)

EC 103 D 1 75

Device Type
TCR = TO–92 . . . . (Isolated)
EC = TO–92 . . . .(Isolated)
T = TO–202AB . . . . . (Non-Isolated)
2N = JEDEC . . . .(Isolated)

Current Rating (for: TCR)
22 = 1.5 Amps

Current Rating (for: EC)
103 = 0.8 Amps
113 = 0.8 Amps

Current Rating (for: T)
106 = 4.0 Amps (IGT = 200µA)
107 = 4.0 Amps (IGT = 500µA)

Current Rating (for: 2N)
5060 = 0.8 Amps
5061 = 0.8 Amps
5062 = 0.8 Amps
5063 = 0.8 Amps
5064 = 0.8 Amps
6564 = 0.8 Amps
6565 = 0.8 Amps

Voltage Rating (for: TCR)
-2 = 50V
-3 = 100V
-4 = 200V
-6 = 400V
-8 = 600V

Voltage Rating (for: EC & T)
A = 100V
B = 200V
C = 300V
D = 400V
E = 500V
F = 50V
M = 600V

Voltage Rating (for: 2N)
5060 = 30V
5061 = 60V
5062 = 100V
5063 = 150V
5064 = 200V
6564 = 300V
6565 = 400V

Gate Current (for: EC series only)
None = 200µA
1 = 12µA
2 = 50µA
3 = 500µA

Lead Form Dimensions
TO–92 *
TO-202AB *

* See "Lead Form Dimensions" section in this catalog for detailed information.

SCR

S 20 08 F 12 X

Device Type
S = NON.SEN.SCR

Voltage Rating
05 = 50V
10 = 100V
20 = 200V
40 = 400V
60 = 600V
80 = 800V

Current Rating

01 = 1.0 Amp	20 = 20.0 Amps
06 = 6.0 Amps	25 = 25.0 Amps
08 = 8.0 Amps	35 = 35.0 Amps
10 = 10.0 Amps	55 = 55.0 Amps
12 = 12.0 Amps	65 = 65.0 Amps
15 = 15.0 Amps	70 = 70.0 Amp s
16 = 16.0 Amps	

Special Options
V=4000V Isolation
(TO-220 Pkg. Only)

Lead Form Dimensions
TO–202AB *
TO–220AB *
TO–92 *
TO–218X *
TO–218AC *

Package Type
E = TO–92 . . . . (Isolated)
F = TO–202AB . . .. (Non-Isolated)
J = TO–218X . . . . (Isolated)
K = TO–218AC . . .. (Isolated)
L = TO–220AB . . . . (Isolated)
M = TO–218AC . . ..(Non-Isolated)
R = TO–220AB . . . . (Non-Isolated)
W = TO–218X . . . . (Non-Isolated)

* See “Lead Form Dimensions” section in this catalog for detailed information.

RECTIFIER

D 20 15 L 55 V

Device Type
D = RECTIFIER

Voltage Rating
05 = 50V
20 = 200V
40 = 400V
60 = 600V
80 = 800V

Current Rating
15 = 15.0 Amps
20 = 20.0 Amps
25 = 25.0 Amps

Special Options
V=4000V Isolation

Lead Form Dimensions
TO–220AB *

Package Type
L = TO–220AB . . . . (Isolated)

* See “Lead Form Dimensions” section in this catalog for detailed information.

DIAC

HT 32 91

Device Type
HT = DIAC TRIGGER

Lead Form Dimensions *
DO–35

Voltage Rating

32 = 27–37V	32A/5761 = 28–36V
35 = 30–40V	32B/5761A = 30–34V
40 = 35–45V	34B = 32-36V
60 = 56–70V	36A/5762 = 32–40V
	36B = 34-38V

* See “Lead Form Dimensions” section in this catalog for detailed information.

SIDAC

K 105 0 E 70

Device Type
K = SIDAC

Voltage Rating

105 = 95–113V	200 = 190-215V
110 = 104–118V	220 = 205-230V
120 = 110–125V	240 = 220-250V
130 = 120–138V	250 = 240-280V
140 = 130–146V	300 = 270-330V
150 = 140–170V	

Lead Form Dimensions *
TO–202AB
TO–92

Package Type
E = TO–92 . . . . (Isolated)
F = TO–202AB. . . . . (Non-Islolated)
G = DO–15X . . . . (Isolated)

Current Rating
0 = 1.0 Amp
1 = High Frequency Commu tation

* See “Lead Form Dimensions” section in this catalog for detailed information.

Part Number Index

Part Number Index

Sensitive Triacs

Teccor's sensitive gate triacs are AC bidirectional silicon switches which provide guaranteed gate trigger current levels in Quadrants I, II, III, and IV. Interfacing to microprocessors or other equipment with single polarity gate triggering is made possible with sensitive gate triacs. Gate triggering currents of 3, 5, 10, or 20 mA may be specified.

Sensitive gate triacs are capable of controlling AC load currents from 0.8 to 8 amperes RMS and can withstand operating voltages from 200 to 600 volts.

Triacs

Teccor's triac products are bidirectional AC switches, capable of controlling loads from 0.8 to 40 amperes RMS.

Triacs are useful in full-wave AC applications to control AC power either through full-cycle switching or phase control of current to the load element. These triacs are rated to block voltage in the "OFF" condition from 200 volts minimum with selected products capable of 800 volt operation. Typical applications include motor speed controls, heater controls and incandescent light controls.

QUADRACs

The QUADRAC, originally developed by Teccor, is a triac with a diac trigger mounted inside the same package. These devices save the user the expense and assembly time of buying a discrete diac and assembling in conjunction with a gated triac.

The QUADRAC is offered in capacities from 4 to 15 amperes RMS and voltages from 200 to 600 VAC.

Alternistors

The Teccor alternistor has been specifically designed for applications which are required to switch highly inductive loads. To accomplish this, a special chip has been designed which effectively offers the same performance as **two thyristors** (SCRs) wired inverse parallel **(back-to-back).**

This new chip construction provides two electrically separate SCR structures, providing enhanced dv/dt characteristics while retaining the advantages of a single chip device.

Teccor manufactures 6 to 40 ampere alternistors with blocking voltage rating from 200 to 800 volts. Alternistors are offered in Fastpak, TO-220AB, TO-218AC, and TO-218(X) packages with isolated and non-isolated versions.

Sensitive SCRs

Teccor's sensitive gate SCRs are silicon controlled rectifiers representing the best in design, performance and packaging techniques for low and medium current applications.

Anode currents of 0.8 to 10 amperes RMS can be controlled by sensitive gate SCRs with gate drive currents ranging from 12 to 500μA. Sensitive gate SCRs are ideally suited for interfacing to integrated circuits or in applications where high current load requirements and limited gate drive current capabilities exist. Some examples include ignition circuits, motor controls and DC latching for alarms in smoke detectors. Available in voltage ratings to 600 VAC.

SCRs

Teccor's SCR products are half-wave silicon controlled rectifiers that represent the state of the art in design and performance.

Load current capabilities range from 1 to 70 amperes RMS and voltages from 30 volts up to 800 volts may be specified, meeting a variety of application needs.

Because of its unidirectional switching capability, the SCR is used in circuits where high surge currents or latching action is required. It may also be used for half-wave-type circuits where gate-controlled rectification action is required. Crowbars in power supplies, camera flash units, smoke alarms, motor controls, battery chargers, and engine ignition are examples of these type applications.

Surge current ratings from 30 amperes in TO-92 packaging to 950 amperes in the new TO-218X package are available.

Rectifiers

Teccor manufactures 15 to 25 ampere (RMS) rectifiers with voltages rated from 50 to 800 volts. Due to the electrically isolated TO-220 package, these rectifiers may be used in common anode or common cathode circuits using only one part type, thereby simplifying stock requirements.

Diacs

Diac trigger devices are thyristors used in phase control circuits to provide gate pulses to a triac or SCR. They are voltage-triggered bidirectional silicon devices housed in a DO-35 glass axial lead package.

Diac voltage selections from 27 volts to 70 volts provide trigger pulses closely matched in symmetry at the positive and negative breakover points to minimize DC component in the load circuit.

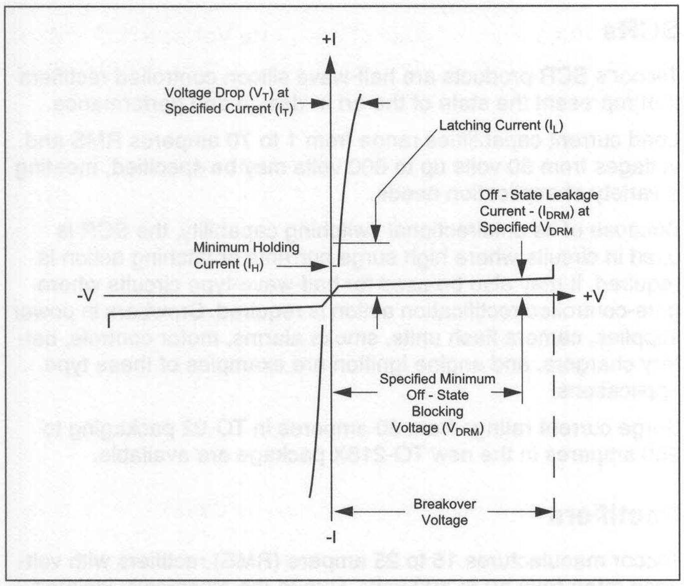
Some applications include gate triggers for light controls, dimmers, power pulse circuits, voltage references in AC power circuits, and triac triggers in motor speed controls.

Sidacs

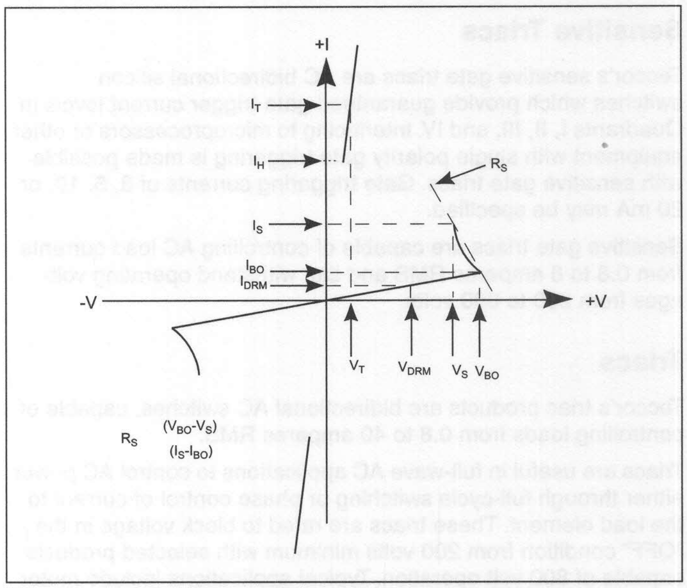
Sidacs represent a unique set of thyristor qualities. The sidac is a bidirectional voltage triggered switch. Some characteristics of this device include a normal 95 to 330 volt switching point, negative resistance range, latching characteristics at turn-on and a low on-state voltage drop.

One cycle surge current capability up to 20 amps makes the sidac an ideal product for dumping charged capacitors through an inductor in order to generate high-voltage pulses. Applications include light controls, high-pressure sodium lamp starters, power oscillators and high-voltage power supplies.

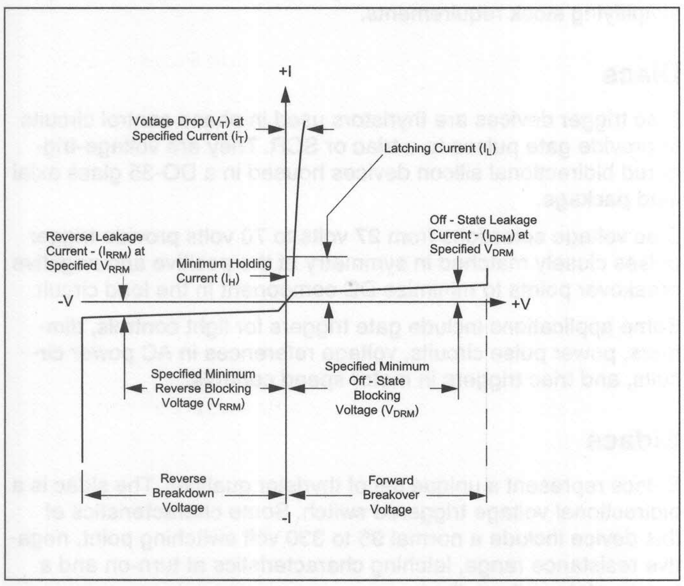
V-I Characteristics of Thyristor Devices



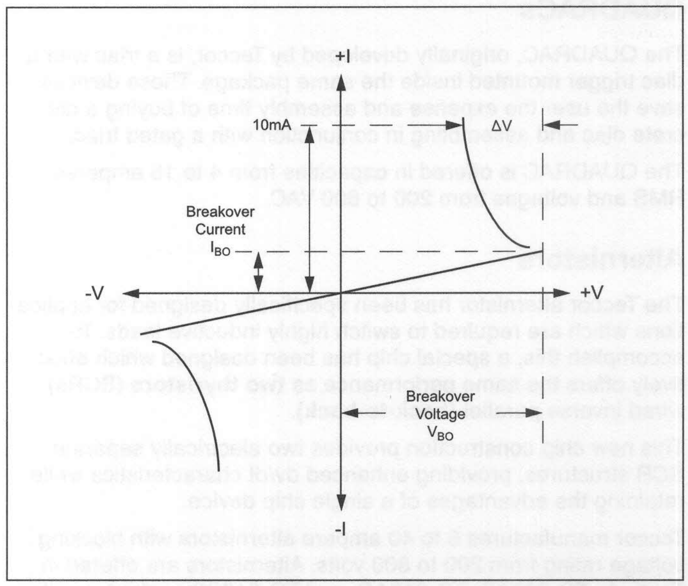
V-I Characteristics of Triac Device



V-I Characteristics of Sidac Device with Negative Resistance



V-I Characteristics of SCR Device



V-I Characteristics of Bilateral Trigger Diac

Thyristors

V_{BO} (Breakover Voltage) – The principal voltage at the breakover point.

V_{DRM} (Repetitive Peak Off-State Voltage) – The maximum allowable instantaneous value of repetitive off-state voltage that may be applied across a bidirectional thyristor (forward or reverse direction) or SCR (forward direction only).

V_{RRM} (Repetitive Peak Reverse Voltage) – The maximum allowable instantaneous value of a repetitive reverse voltage that may be applied across an SCR without causing reverse current avalanche.

V_T (On-State Voltage) – The principal voltage when the thyristor is in the on-state.

V_{GT} (Gate Trigger Voltage) – The minimum gate voltage required to produce the gate trigger current.

I_{BO} (Breakover Current) – The principal current at the breakover point.

I_{DRM} (Repetitive Peak Off-State Current) – The maximum leakage current that may occur under the conditions of V_{DRM}.

I_{RRM} (Repetitive Peak Reverse Current) – The maximum leakage current that may occur under the conditions of V_{RRM}.

$I_{T(RMS)}$ (On-State Current) – The anode cathode principal current that may be allowed under stated conditions, usually the full-cycle RMS current.

I_{TSM} (Surge (Non-Repetitive) On-State Current) – The peak single cycle A.C. current pulse allowed.

I_H (Holding Current) – The minimum principal current required to maintain the thyristor in the on-state.

I_{GT} (Gate Trigger Current) – The minimum gate current required to switch a thyristor from the off-state to the on-state.

P_{GM} (Peak Gate Power Dissipation) – The maximum power which may be dissipated between the gate and main terminal 1 (or cathode) for a specified time duration.

$P_{G(AV)}$ (Average Gate Power Dissipation) – The value of gate power which may be dissipated between the gate and main terminal 1 (or cathode) average over a full cycle.

t_{gt} (Gate-controlled Turn-On Time) – The time interval between the 10% rise of the gate pulse and the 90% rise of the principal current pulse during switching of a thyristor from the off-state to the on-state.

t_q (Circuit-Commutated Turn-Off Time) – The time interval between the instant when the principal current has decreased to zero after external switching of the principal voltage circuit, and the instant when the SCR is capable of supporting a specified principal voltage without turning on.

di/dt (Critical Rate-of-Rise Of On-State Current) – The maximum value of the rate-of-rise of on-state current which a thyristor can withstand without deleterious effect.

dv/dt Critical Rate-of-Rise of Off-State Voltage (Critical or Static dv/dt) – The minimum value of the rate-of-rise of principal voltage which will cause switching from the off-state to the on-state.

dv/dt(c) Critical Rate-of-Rise of Commutation Voltage of a Triac (Commutating dv/dt) – The minimum value of the rate-of-rise of principal voltage which will cause switching from the off-state to the on-state immediately following on-state current conduction in the opposite quadrant.

$R_{\theta JA}$ (Thermal Resistance, Junction-to-Ambient) – The temperature difference between the thyristor junction and ambient divided by the power dissipation causing the temperature difference under conditions of thermal equilibrium.

Note: Ambient is defined as the point where temperature does not change as a result of the dissipation.

$R_{\theta JC}$ (Thermal Resistance, Junction-to-Case) – The temperature difference between the thyristor junction and the thyristor case divided by the power dissipation causing the temperature difference under conditions of thermal equilibrium.

I_{PP} (Peak Pulse Current) – The peak pulse current at a short time duration and specified waveshape.

I^2t (RMS Surge (Non-Repetitive) On-State Fusing Current) – It is a measure of let-through energy in terms of current and time for fusing purposes.

V_S (Switching Voltage) – The voltage point after V_{BO} when a sidac switches from a clamping state to on-state.

I_S (Switching Current) – The current at V_S when a sidac switches from the clamping state to on-state.

Diode Rectifiers

V_{RRM} (Maximum (Peak) Repetitive Reverse Voltage) – The maximum peak allowable value of a repetitive reverse voltage that may be applied to the rectifier.

V_R (Reverse Blocking Voltage) – The maximum allowable D.C. reverse blocking voltage that may be applied to the rectifier.

$I_{F(AV)}$ (Average Forward Current) – The average forward conduction current.

$I_{F(RMS)}$ (RMS Forward Current) – The RMS forward conduction current.

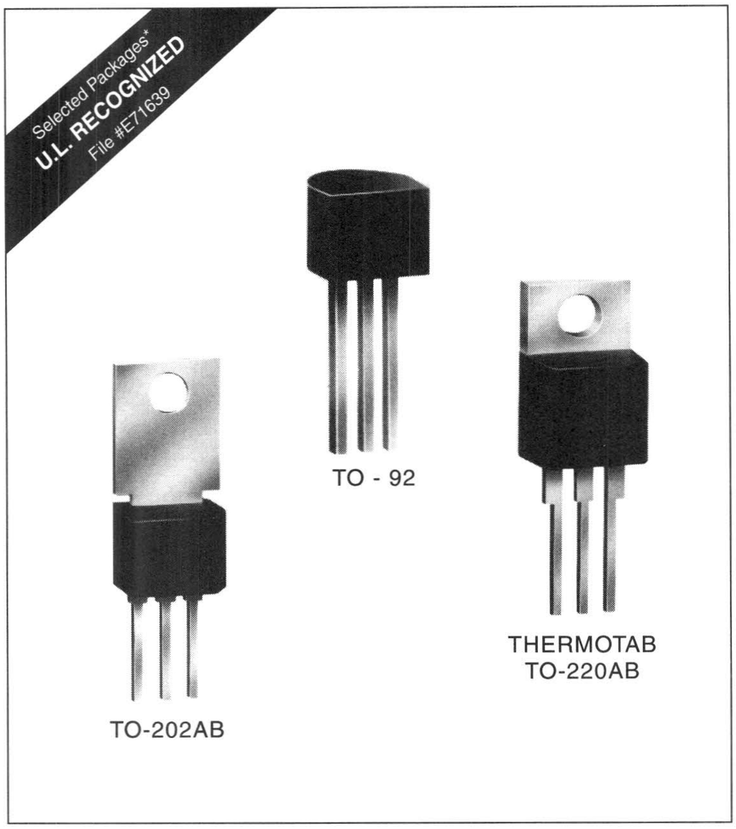
I_{FSM} (Maximum (Peak) Forward (Non-Repetitive) Surge Current) – The maximum (peak) forward single cycle A.C. surge current allowed for specified duration.

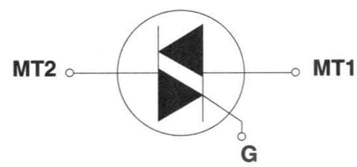
V_{FM} (Maximum (Peak) Forward Voltage Drop) – The maximum (peak) forward voltage drop from the anode to cathode at stated conditions.

I_{FM} (Maximum (Peak) Reverse Current) – The maximum reverse leakage current that may occur at rated V_{RRM}.

Notes

Product Data Sheets





Sensitive Triacs

(0.8 – 8.0 Amps)

General Description

Teccor's line of sensitive gate triacs includes devices with current capabilities through 8 amperes. Voltage ranges are available from 200 to 600 volts. This line features devices with guaranteed gate control in the second and fourth quadrants as well as control in the commonly used first and third quadrants. Four-quadrant control devices require sensitive gate triacs. They lend themselves to be controlled by digital circuitry where positive-only or negative-only pulses must control AC current in both directions through the device. It should be noted that triacs with low I_{GT} values in the second and fourth quadrants will have lower dv/dt characteristics.

The sensitive gate triac is a bidirectional AC switch and is gate controlled for either polarity of main terminal voltage. Its primary purpose is for AC switching and phase control applications such as motor speed controls, temperature modulation controls, and lighting controls.

A wide range of package variations are available. The plastic TO-92 and THERMOTAB configurations feature Teccor's electrically isolated construction where the case or mounting tab is internally isolated from the semiconductor chip and lead attachments. Non-isolated plastic TO-202 packages are available. Tape-and-reel capability and tube packing also are available. See “Packing Options” section of this catalog.

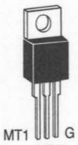
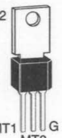
All Teccor triacs have glass passivated junctions. This glassing process prevents migration of contaminants and ensures long-term device reliability with parameter stability.

Variations of devices covered in this data sheet are available for custom design applications. Please consult the factory for more information.

Features

- **Electrically-isolated packages**
- **Glass-passivated junctions ensure long device reliability and parameter stability**
- **Voltage capability — up to 600 Volts**
- **Surge capability — up to 80 Amps**

Electrical Specifications

$I_{T(RMS)}$	Part No.			V_{DRM}	I_{GT}				I_{DRM}		V_{TM}	V_{GT}	
		Isolated	Non-Isolated										
RMS On-State Current Conduction Angle of 360° (11)	 MT1 MT2 G TO-92	 MT1 G MT2 THERMOTAB TO-220	 MT2 MT1 G MT2 TO-202AB	Repetitive Peak Blocking Voltage (1)	DC Gate Trigger Current in Specific Operating Quadrants V_D = 12VDC R_L = 60Ω (3) (6) mAmps				Peak Off-State Current Gate Open V_{DRM} = Max Rated Value (1) (13) mAmps		Peak On-State Voltage at Max Rated RMS Current T_C = 25°C (1) (4)	DC Gate Trigger Voltage V_D = 12VDC R_L = 60Ω (2) (5) Volts	
				Volts	QI	QII	QIII	QIV	T_C = 25°C	T_C = 110°C	Volts	T_C = 110°C	T_C = 25°C
MAX	See "Package Dimensions" section for variations.			MIN	MAX				MAX	MAX	MAX	MIN	MAX
0.8 Amp	L2X8E3			200	3	3	3	3	.01	0.1	1.6	0.2	2.0
	L4X8E3			400	3	3	3	3	.01	0.1	1.6	0.2	2.0
	L6X8E3			600	3	3	3	3	.01	0.1	1.6	0.2	2.0
	L2X8E5			200	5	5	5	5	.01	0.1	1.6	0.2	2.0
	L4X8E5			400	5	5	5	5	.01	0.1	1.6	0.2	2.0
	L6X8E5			600	5	5	5	5	.01	0.1	1.6	0.2	2.0
	L2X8E6			200	5	5	5	10	.01	0.1	1.6	0.2	2.0
	L4X8E6			400	5	5	5	10	.01	0.1	1.6	0.2	2.0
	L6X8E6			600	5	5	5	10	.01	0.1	1.6	0.2	2.0
	L2X8E8			200	10	10	10	20	.01	0.1	1.6	0.2	2.0
	L4X8E8			400	10	10	10	20	.01	0.1	1.6	0.2	2.0
	L6X8E8			600	10	10	10	20	.01	0.1	1.6	0.2	2.0
1.0 Amp	L201E3			200	3	3	3	3	.01	0.1	1.6	0.2	2.0
	L401E3			400	3	3	3	3	.01	0.1	1.6	0.2	2.0
	L601E3			600	3	3	3	3	.01	0.1	1.6	0.2	2.0
	L201E5			200	5	5	5	5	.01	0.1	1.6	0.2	2.0
	L401E5			400	5	5	5	5	.01	0.1	1.6	0.2	2.0
	L601E5			600	5	5	5	5	.01	0.1	1.6	0.2	2.0
	L201E6			200	5	5	5	10	.01	0.1	1.6	0.2	2.0
	L401E6			400	5	5	5	10	.01	0.1	1.6	0.2	2.0
	L601E6			600	5	5	5	10	.01	0.1	1.6	0.2	2.0
	L201E8			200	10	10	10	20	.01	0.1	1.6	0.2	2.0
	L401E8			400	10	10	10	20	.01	0.1	1.6	0.2	2.0
	L601E8			600	10	10	10	20	.01	0.1	1.6	0.2	2.0
4.0 Amps		L2004L3	L2004F31	200	3	3	3	3	.01	0.2	1.6	0.2	2.0
		L4004L3	L4004F31	400	3	3	3	3	.01	0.2	1.6	0.2	2.0
		L6004L3	L6004F31	600	3	3	3	3	.01	0.2	1.6	0.2	2.0
		L2004L5	L2004F51	200	5	5	5	5	.01	0.2	1.6	0.2	2.0
		L4004L5	L4004F51	400	5	5	5	5	.01	0.2	1.6	0.2	2.0
		L6004L5	L6004F51	600	5	5	5	5	.01	0.2	1.6	0.2	2.0
		L2004L6	L2004F61	200	5	5	5	10	.01	0.2	1.6	0.2	2.0
		L4004L6	L4004F61	400	5	5	5	10	.01	0.2	1.6	0.2	2.0
		L6004L6	L6004F61	600	5	5	5	10	.01	0.2	1.6	0.2	2.0
		L2004L8	L2004F81	200	10	10	10	20	.01	0.2	1.6	0.2	2.0
		L4004L8	L4004F81	400	10	10	10	20	.01	0.2	1.6	0.2	2.0
		L6004L8	L6004F81	600	10	10	10	20	.01	0.2	1.6	0.2	2.0
6.0 Amps		L2006L5		200	5	5	5	5	.02	0.5	1.6	0.2	2.0
		L4006L5		400	5	5	5	5	.02	0.5	1.6	0.2	2.0
		L6006L5		600	5	5	5	5	.02	0.5	1.6	0.2	2.0
		L2006L6		200	5	5	5	10	.02	0.5	1.6	0.2	2.0
		L4006L6		400	5	5	5	10	.02	0.5	1.6	0.2	2.0
		L6006L6		600	5	5	5	10	.02	0.5	1.6	0.2	2.0
		L2006L8		200	10	10	10	20	.02	0.5	1.6	0.2	2.0
		L4006L8		400	10	10	10	20	.02	0.5	1.6	0.2	2.0
		L6006L8		600	10	10	10	20	.02	0.5	1.6	0.2	2.0
8.0 Amps		L2008L6		200	5	5	5	10	.02	0.5	1.6	0.2	2.0
		L4008L6		400	5	5	5	10	.02	0.5	1.6	0.2	2.0
		L6008L6		600	5	5	5	10	.02	0.5	1.6	0.2	2.0
		L2008L8		200	10	10	10	20	.02	0.5	1.6	0.2	2.0
		L4008L8		400	10	10	10	20	.02	0.5	1.6	0.2	2.0
		L6008L8		600	10	10	10	20	.02	0.5	1.6	0.2	2.0

See General Notes and Electrical Specification Notes on page 1-4.

I_H	I_{GTM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt(c)	dv/dt	t_{gt}	I^2t	di/dt
Holding Current Gate Open Initial On-State Current = 200mADC (1) (7)	Peak Gate Trigger Current (12)	Peak Gate Power Dissipation $I_{GT} \le I_{GTM}$ (12)	Average Gate Power Dissipation	Peak One Cycle Surge (8) (10) Amps		Critical Rate-of-Rise of Commutation Voltage at Rated V_{DRM} and $I_{T(RMS)}$ Commutating di/dt = 0.54 Rated $I_{T(RMS)}$/ms Gate Unenergized (1) (10)	Critical Rate-of-Rise of Off-State Voltage at Rated V_{DRM} Gate Open (1) Volts/µSec	Gate Controlled Turn-On Time I_{GT} = 50mA 0.1µs Rise Time	RMS Surge (Non-Repetitive) On-State Current for Period of 8.3ms for Fusing	Maximum Rate-of-Change of On-State Current I_{GT} = 50mA With 0.1µs Rise Time
mAmps	Amps	Watts	Watts	60Hz	50Hz	Volts/µSec	T_C = 100˚C	µSec	$Amps^2Sec$	Amps/µSec
MAX						TYP	TYP	TYP		
5	1.0	10	0.2	10	8.3	0.5	20	2.8	0.41	20
5	1.0	10	0.2	10	8.3	0.5	15	2.8	0.41	20
5	1.0	10	0.2	10	8.3	0.5	10	2.8	0.41	20
10	1.0	10	0.2	10	8.3	1.0	20	3.0	0.41	20
10	1.0	10	0.2	10	8.3	1.0	15	3.0	0.41	20
10	1.0	10	0.2	10	8.3	1.0	10	3.0	0.41	20
10	1.0	10	0.2	10	8.3	1.0	30	3.0	0.41	20
10	1.0	10	0.2	10	8.3	1.0	25	3.0	0.41	20
10	1.0	10	0.2	10	8.3	1.0	20	3.0	0.41	20
15	1.0	10	0.2	10	8.3	2.0	35	3.2	0.41	20
15	1.0	10	0.2	10	8.3	2.0	30	3.2	0.41	20
15	1.0	10	0.2	10	8.3	2.0	25	3.2	0.41	20
5	1.0	10	0.2	20	16.7	0.5	20	2.8	1.6	20
5	1.0	10	0.2	20	16.7	0.5	20	2.8	1.6	20
5	1.0	10	0.2	20	16.7	0.5	10	2.8	1.6	20
10	1.0	10	0.2	20	16.7	1	20	3.0	1.6	20
10	1.0	10	0.2	20	16.7	1	20	3.0	1.6	20
10	1.0	10	0.2	20	16.7	1	10	3.0	1.6	20
10	1.0	10	0.2	20	16.7	1	30	3.0	1.6	20
10	1.0	10	0.2	20	16.7	1	30	3.0	1.6	20
10	1.0	10	0.2	20	16.7	1	20	3.0	1.6	20
15	1.0	10	0.2	20	16.7	1	35	3.2	1.6	20
15	1.0	10	0.2	20	16.7	1	35	3.2	1.6	20
15	1.0	10	0.2	20	16.7	1	25	3.2	1.6	20
5	1.2	15	0.3	40	33	0.5	25	2.8	6.6	50
5	1.2	15	0.3	40	33	0.5	25	2.8	6.6	50
5	1.2	15	0.3	40	33	0.5	15	2.8	6.6	50
10	1.2	15	0.3	40	33	1	25	3.0	6.6	50
10	1.2	15	0.3	40	33	1	25	3.0	6.6	50
10	1.2	15	0.3	40	33	1	10	3.0	6.6	50
10	1.2	15	0.3	40	33	1	30	3.0	6.6	50
10	1.2	15	0.3	40	33	1	30	3.0	6.6	50
10	1.2	15	0.3	40	33	1	20	3.0	6.6	50
15	1.2	15	0.3	40	33	2	35	3.2	6.6	50
15	1.2	15	0.3	40	33	2	35	3.2	6.6	50
15	1.2	15	0.3	40	33	2	25	3.2	6.6	50
10	1.6	18	0.4	60	50	1	40	3.0	15.0	70
10	1.6	18	0.4	60	50	1	30	3.0	15.0	70
10	1.6	18	0.4	60	50	1	20	3.0	15.0	70
10	1.6	18	0.4	60	50	2	40	3.0	15.0	70
10	1.6	18	0.4	60	50	2	30	3.0	15.0	70
10	1.6	18	0.4	60	50	2	25	3.0	15.0	70
15	1.6	18	0.4	60	50	2	45	3.2	15.0	70
15	1.6	18	0.4	60	50	2	40	3.2	15.0	70
15	1.6	18	0.4	60	50	2	30	3.2	15.0	70
10	1.6	18	0.4	80	65	2	40	3.0	26.5	70
10	1.6	18	0.4	80	65	2	30	3.0	26.5	70
10	1.6	18	0.4	80	65	2	20	3.0	26.5	70
15	1.6	18	0.4	80	65	2	45	3.2	26.5	70
15	1.6	18	0.4	80	65	2	40	3.2	26.5	70
15	1.6	18	0.4	80	65	2	30	3.2	26.5	70

See General Notes and Electrical Specification Notes on page 1-4.

Electrical Specifications

General Notes

- All measurements are made with 60Hz resistive load and at an ambient temperature of +25°C unless otherwise specified.
- Operating temperature range (T_J) is -65°C to +110°C for TO-92 devices; -40°C to 110°C for all other devices.
- Storage temperature range (T_S) is -65°C to +150°C for TO-92 devices; -40°C to +150°C for TO-202 devices; and -40°C to +125°C for TO-220 devices.
- Lead solder temperature is a maximum of 230°C for 10 seconds maximum at a minimum of 1/16" (1.59mm) from case.
- The case temperature (T_C) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.

Electrical Specification Notes

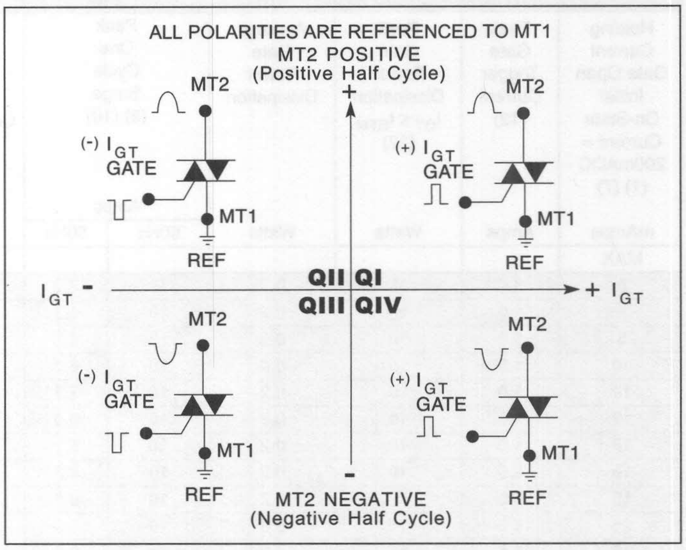
(1) For either polarity of MT2 with reference to MT1 terminal.
(2) For either polarity of gate voltage V_{GT} with reference to MT1 terminal.
(3) See definition of quadrants and gate characteristics.
(4) See Figure 1.4 for i_T vs v_T.
(5) See Figure 1.6 for V_{GT} vs T_C.
(6) See Figure 1.7 for I_{GT} vs T_C.
(7) See Figure 1.5 for I_H vs T_C.
(8) See Figure 1.9 for surge rating and specific duration.
(9) See Figure 1.8 for t_{gt} vs I_{GT}.
(10) See Figures 1.2 and 1.3 for maximum allowable case temperature at maximum rated current.
(11) See Figures 1.1, 1.2, and 1.3 for T_A or T_C vs I_T(RMS).
(12) Pulse width ≤ 10µs.
(13) $T_C = T_J$ for test conditions in off-state.

Gate Characteristics

Teccor triacs may be turned on between gate and MT1 terminals in the following ways:

- With in-phase signals (using standard AC line) Quadrants I and III are used.
- By applying unipolar pulses (gate always positive or negative) — with negative gate pulses Quadrants II and III are used and with positive gate pulses Quadrants I and IV are used.

When maximum surge capability is required, pulses should be a minimum of one magnitude above I_{GT} rating with a steep rising waveform (≤ 1µsec rise time).



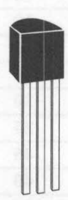
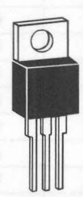
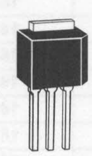
Definition of Quadrants

Electrical Isolation

Teccor's isolated triac packages will withstand a minimum high potential test of 2500 VAC RMS from leads to mounting tab over the device's operating temperature range. See isolation table below for standard isolation ratings.

ELECTRICAL ISOLATION FROM LEADS TO MOUNTING TAB	
VAC(RMS)	TO-220AB THERMOTAB *
2500	Standard

* U.L. Recognized File #E71639

THERMAL RESISTANCE (STEADY STATE) JUNCTION TO MOUNTING TAB AND JUNCTION TO AMBIENT $R_{\theta JC}$ [$R_{\theta JA}$] °C/W (TYP)				
TYPE	 Plastic TO-92	 TO-202AB TYPE 1	 TO-220AB THERMOTAB	 TO-202AB TYPE 2
0.8 Amp	60 [135]			
1.0 Amp	50 [95]			
4.0 Amps		3.5 [45]	3.6 [50]	6.0 [70]
6.0 Amps			3.3	
8.0 Amps			2.8	

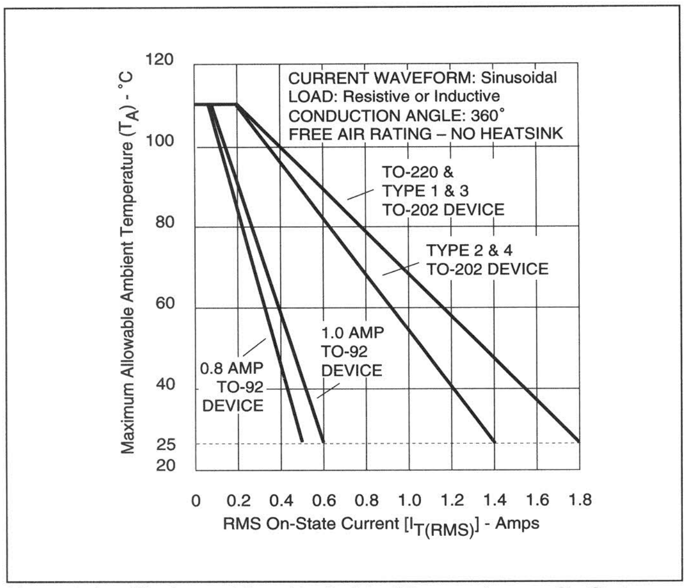


Figure 1.1 Maximum Allowable Ambient Temperature vs On-State Current

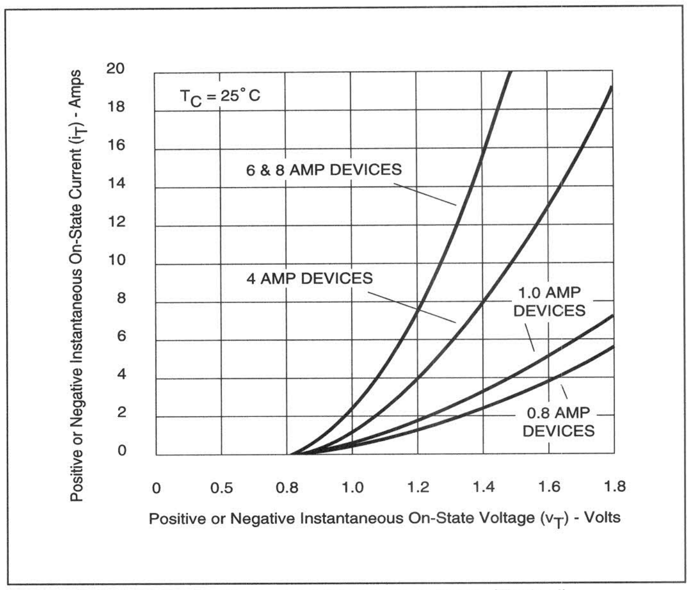


Figure 1.4 On-State Current vs On-State Voltage (Typical)

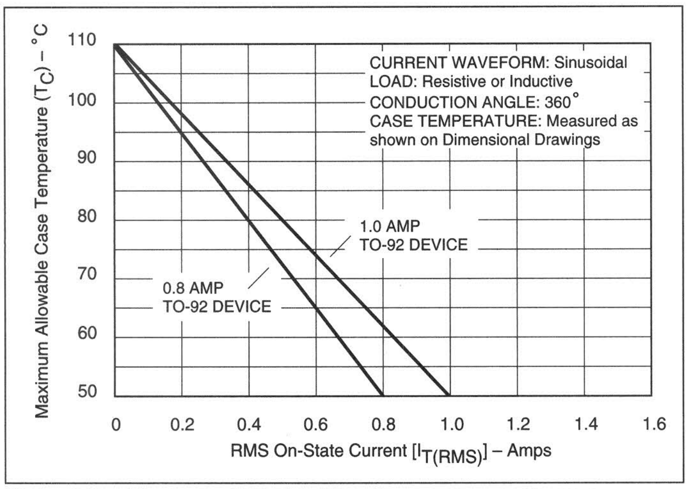


Figure 1.2 Maximum Allowable Case Temperature vs On-State Current (0.8 and 1.0 Amp)

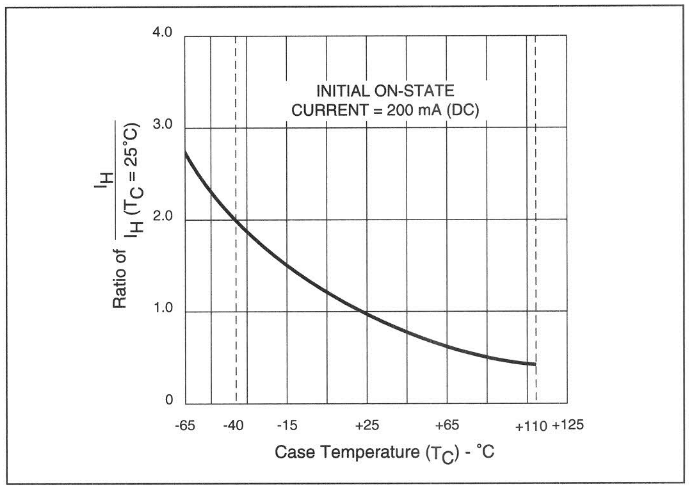


Figure 1.5 Normalized DC Holding Current vs Case Temperature

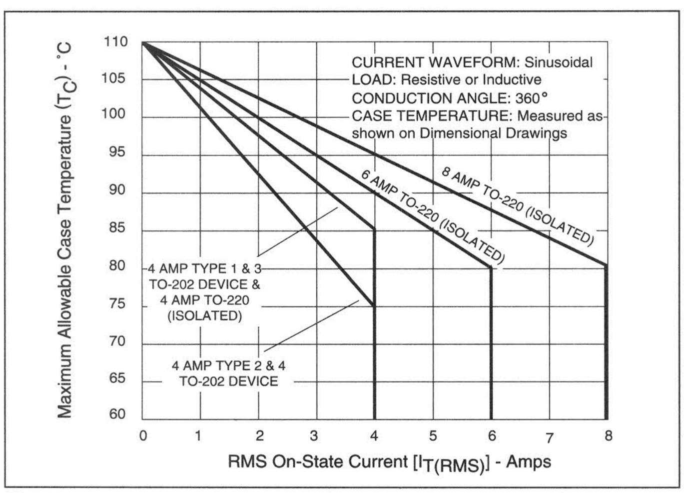


Figure 1.3 Maximum Allowable Case Temperature vs On-State Current (4, 6, and 8 Amp)

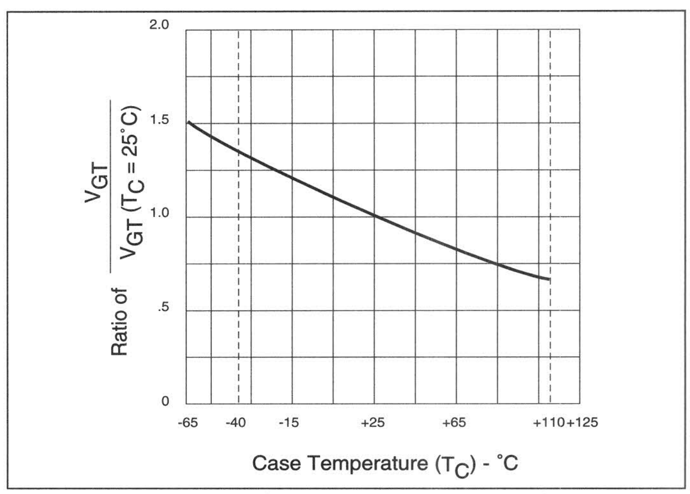


Figure 1.6 Normalized DC Gate Trigger Voltage for All Quadrants vs Case Temperature

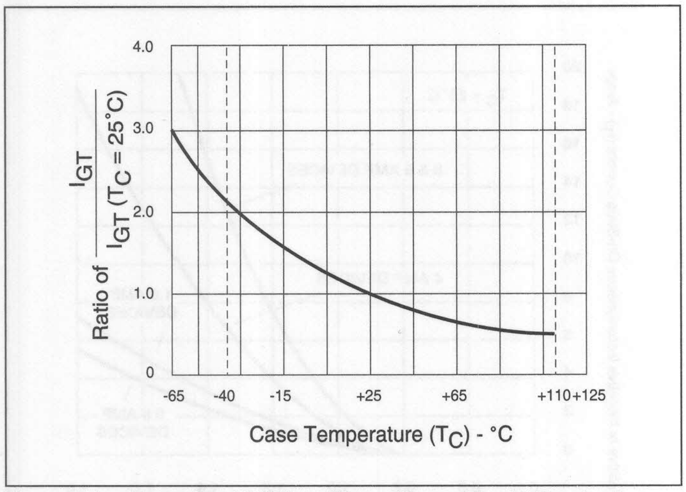


Figure 1.7 Normalized DC Gate Trigger Current for All Quadrants vs Case Temperature

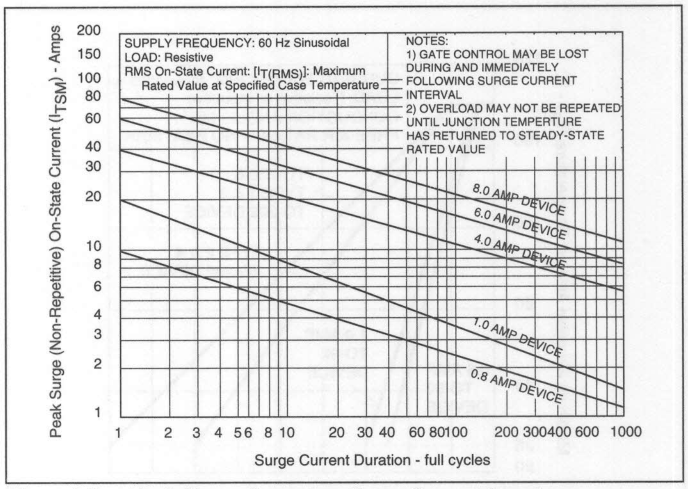


Figure 1.9 Peak Surge Current vs Surge Current Duration

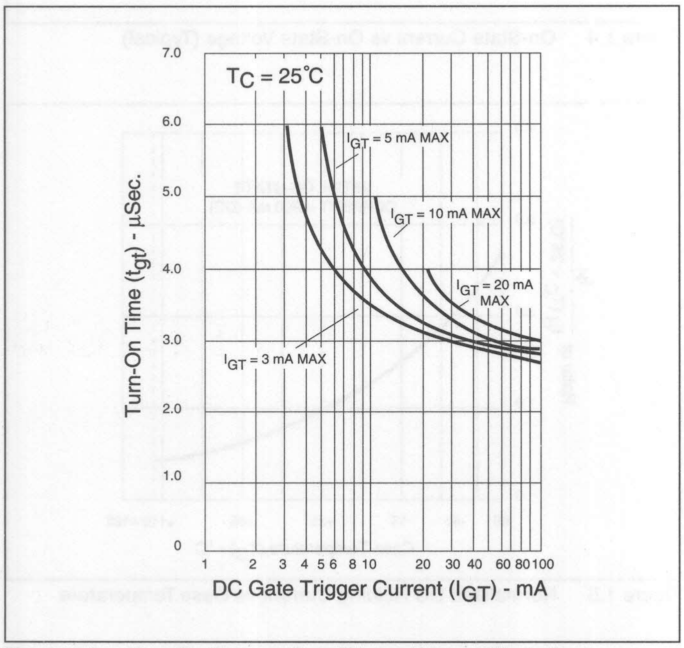


Figure 1.8 Turn-On Time vs Gate Trigger Current (Typical)

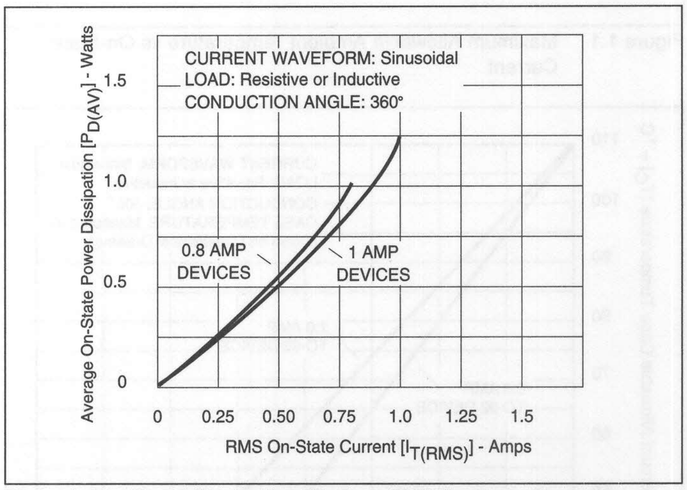


Figure 1.10 Power Dissipation (Typ.) vs RMS On-State Current (0.8 and 1 Amp)

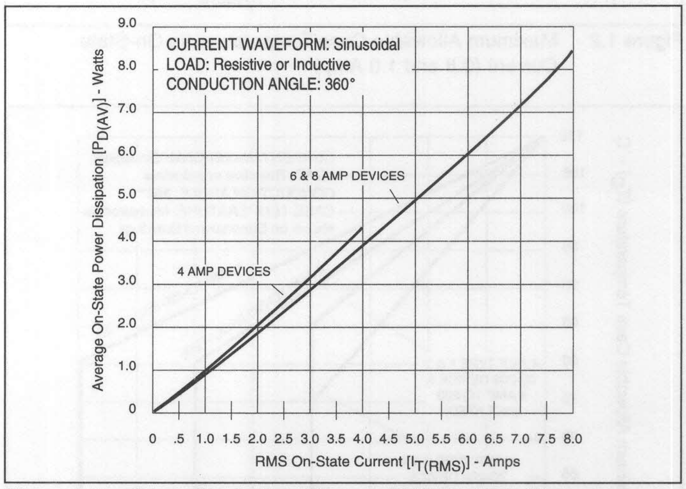
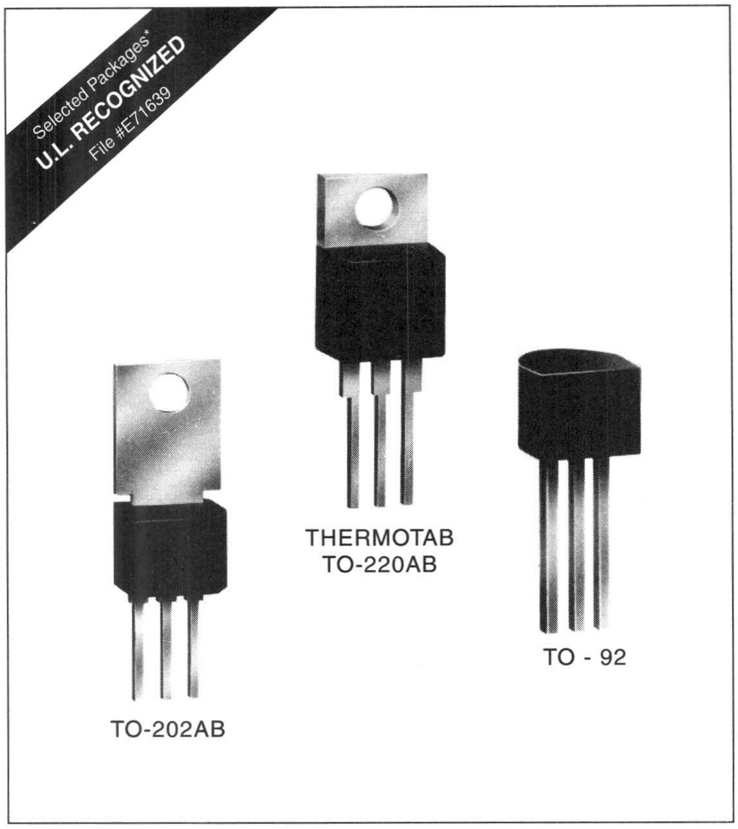
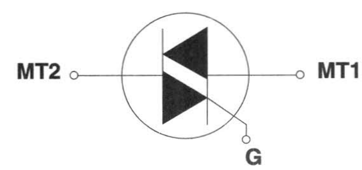


Figure 1.11 Power Dissipation (Typ.) vs RMS On-State Current (4, 6, and 8 Amp)





Triacs

(0.8 – 25 Amps)

General Description

These gated triacs from Teccor Electronics are part of a broad line of bidirectional semiconductors. The devices range in current ratings from 0.8 to 25 amperes and in voltages from 200 to 800 volts.

The triac may be gate triggered from a blocking to conduction state for either polarity of applied voltage and is designed for AC switching and phase control applications such as speed and temperature modulation controls, lighting controls and static switching relays. The triggering signal is normally applied between the gate and MT1.

Teccor's gated triacs are available in a choice of different packages as shown above. Isolated packages are offered with internal construction, having the case or mounting tab electrically isolated from the semiconductor chip. This feature facilitates the use of low-cost assembly and convenient packaging techniques. Tape-and-reel capability is available. See “Packing Options” section of this catalog.

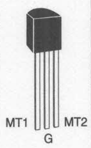
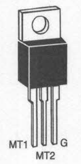
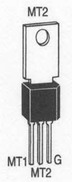
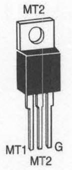
All Teccor triacs have glass-passivated junctions to ensure long term device reliability and parameter stability. Teccor's glass offers a rugged, reliable barrier against junction contamination.

Variations of devices covered in this data sheet are available for custom design applications. Please consult factory for more information.

Features

- **Electrically-isolated packages**
- **Glass-passivated junctions**
- **Voltage capability — up to 800 Volts**
- **Surge capability — up to 200 Amps**

Electrical Specifications

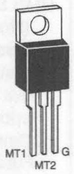
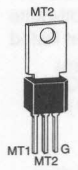
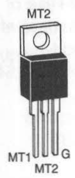
$I_{T(RMS)}$	Part Number				V_{DRM}	I_{GT}					I_{DRM}			V_{TM}	V_{GT}	
		Isolated	Non-Isolated													
RMS On-State Current Conduction Angle of 360˚ (4)					Repetitive Peak Blocking Voltage (1)	DC Gate Trigger Current in Specific Operating Quadrants V_D = 12VDC R_L = 60Ω (3) (7) mAmps					Peak Off-State Current Gate Open V_{DRM} = Max Rated Value (1) (16) mAmps			Peak On-State Voltage at Max Rated RMS Current T_C = 25˚C (1) (5)	DC Gate Trigger Voltage V_D = 12VDC R_L = 60Ω (2) (6) (18) Volts	
	TO-92	THERMOTAB TO-220AB	TO-202AB	TO-220AB	Volts	QI	QII	QIII	QIV	QIV	T_C = 25˚C	T_C = 100˚C	T_C = 125˚C	Volts	T_C = 125˚C	T_C = 25˚C
MAX	See "Package Dimensions" section for variations.				MIN	MAX				TYP	MAX			MAX	MIN	MAX
0.8 Amp	Q2X8E3				200	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q4X8E3				400	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q5X8E3				500	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q6X8E3				600	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q2X8E4				200	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
	Q4X8E4				400	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
	Q5X8E4				500	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
	Q6X8E4				600	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
1.0 Amp	Q201E3				200	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q401E3				400	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q501E3				500	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q601E3				600	10	10	10		25	.02	0.5	1.0	1.6	0.2	2.0
	Q201E4				200	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
	Q401E4				400	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
	Q501E4				500	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
	Q601E4				600	25	25	25		50	.02	0.5	1.0	1.6	0.2	2.5
4.0 Amps		Q2004L3	Q2004F31		200	10	10	10		25	.05	0.5	2.0	1.6	0.2	2.0
		Q4004L3	Q4004F31		400	10	10	10		25	.05	0.5	2.0	1.6	0.2	2.0
		Q5004L3	Q5004F31		500	10	10	10		25	.05	0.5	2.0	1.6	0.2	2.0
		Q6004L3	Q6004F31		600	10	10	10		25	.05	0.5	2.0	1.6	0.2	2.0
		Q2004L4	Q2004F41		200	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q4004L4	Q4004F41		400	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q5004L4	Q5004F41		500	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q6004L4	Q6004F41		600	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q7004L4			700	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q8004L4			800	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
6.0 Amps		Q2006L4	Q2006F41	Q2006R4	200	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q4006L4	Q4006F41	Q4006R4	400	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q5006L4	Q5006F41	Q5006R4	500	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q6006L5	Q6006F51	Q6006R5	600	50	50	50		75	.05	0.5	2.0	1.6	0.2	2.5
		Q7006L5		Q7006R5	700	50	50	50		75	.05	0.5	2.0	1.6	0.2	2.5
		Q8006L5		Q8006R5	800	50	50	50		75	.05	0.5	2.0	1.6	0.2	2.5
8.0 Amps		Q2008L4	Q2008F41	Q2008R4	200	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q4008L4	Q4008F41	Q4008R4	400	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q5008L4	Q5008F41	Q5008R4	500	25	25	25		50	.05	0.5	2.0	1.6	0.2	2.5
		Q6008L5	Q6008F51	Q6008R5	600	50	50	50		75	.05	0.5	2.0	1.6	0.2	2.5
		Q7008L5		Q7008R5	700	50	50	50		75	.05	0.5	2.0	1.6	0.2	2.5
		Q8008L5		Q8008R5	800	50	50	50		75	.05	0.5	2.0	1.6	0.2	2.5

See General Notes and Electrical Specification Notes on page 2-4.

I_H	I_{GTM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt (c)	dv/dt		t_{gt}	I^2t	di/dt
Holding Current (DC) Gate Open (1) (8) (12)	Peak Gate Trigger Current (14)	Peak Gate Power Dissipation (14) $I_{GT} \leq I_{GTM}$	Average Gate Power Dissipation	Peak One Cycle Surge (9) (13)		Critical Rate-of-Rise of Commutation Voltage at Rated V_{DRM} and $I_{T(RMS)}$ Commutating di/dt = 0.54 Rated $I_{T(RMS)}$/ms Gate Unenergized (1) (4) (13)	Critical Rate-of-Rise of Off-State Voltage at Rated V_{DRM} Gate Open (1) Volts/µSec		Gate Controlled Turn-On Time I_{GT} = 200mA 0.1µs Rise Time (10)	RMS Surge (Non-Repetitive) On-State Current for Period of 8.3ms for Fusing	Maximum Rate-of-Change of On-State Current I_{GT} = 200mA with 0.1µs Rise Time
mAmps				Amps		Volts/µSec	T_C= 100˚C	T_C= 125˚C	µSec		
MAX	Amps	Watts	Watts	60Hz	50Hz	TYP	MIN		TYP	Amp^2Sec	Amps/µSec
15	1.0	10	0.2	10	8.3	1.0	40	30	2.5	0.41	20
15	1.0	10	0.2	10	8.3	1.0	35	25	2.5	0.41	20
15	1.0	10	0.2	10	8.3	1.0	30	20	2.5	0.41	20
15	1.0	10	0.2	10	8.3	1.0	25	15	2.5	0.41	20
25	1.0	10	0.2	10	8.3	2.0	50	40	3	0.41	20
25	1.0	10	0.2	10	8.3	2.0	45	35	3	0.41	20
25	1.0	10	0.2	10	8.3	2.0	40	30	3	0.41	20
25	1.0	10	0.2	10	8.3	2.0	35	25	3	0.41	20
15	1.0	10	0.2	20	16.7	1.0	40	30	2.5	1.6	30
15	1.0	10	0.2	20	16.7	1.0	40	30	2.5	1.6	30
15	1.0	10	0.2	20	16.7	1.0	30	20	2.5	1.6	30
15	1.0	10	0.2	20	16.7	1.0	30	20	2.5	1.6	30
25	1.0	10	0.2	20	16.7	1.0	50	40	3	1.6	30
25	1.0	10	0.2	20	16.7	1.0	50	40	3	1.6	30
25	1.0	10	0.2	20	16.7	1.0	40	30	3	1.6	30
25	1.0	10	0.2	20	16.7	1.0	40	30	3	1.6	30
20	1.2	15	0.3	55	46	2.0	50	40	2.5	12.5	50
20	1.2	15	0.3	55	46	2.0	50	40	2.5	12.5	50
20	1.2	15	0.3	55	46	2.0	40	30	2.5	12.5	50
20	1.2	15	0.3	55	46	2.0	40	30	2.5	12.5	50
30	1.2	15	0.3	55	46	2.0	100	75	3	12.5	50
30	1.2	15	0.3	55	46	2.0	100	75	3	12.5	50
30	1.2	15	0.3	55	46	2.0	75	50	3	12.5	50
30	1.2	15	0.3	55	46	2.0	75	50	3	12.5	50
30	1.2	15	0.3	55	46	2.0	60	40	3	12.5	50
30	1.2	15	0.3	55	46	2.0	60	40	3	12.5	50
50	1.6	18	0.5	80	65	4.0	200	120	3	26.5	70
50	1.6	18	0.5	80	65	4.0	200	120	3	26.5	70
50	1.6	18	0.5	80	65	4.0	150	100	3	26.5	70
50	1.6	18	0.5	80	65	4.0	150	100	3	26.5	70
50	1.6	18	0.5	80	65	4.0	125	85	3	26.5	70
50	1.6	18	0.5	80	65	4.0	125	85	3	26.5	70
50	1.8	20	0.5	100	83	4.0	250	150	3	41	70
50	1.8	20	0.5	100	83	4.0	250	150	3	41	70
50	1.8	20	0.5	100	83	4.0	220	125	3	41	70
50	1.8	20	0.5	100	83	4.0	220	125	3	41	70
50	1.8	20	0.5	100	83	4.0	150	100	3	41	70
50	1.8	20	0.5	100	83	4.0	150	100	3	41	70

See General Notes and Electrical Specification Notes on page 2-4.

Electrical Specifications

$I_{T(RMS)}$	Part Number: Isolated	Part Number: Non-Isolated		V_{DRM}	I_{GT}					I_{DRM}			V_{GT}	
RMS On-State Current Conduction Angle of 360° (4) (16)	 THERMOTAB TO-220AB	 TO-202AB	 TO-220AB	Repetitive Peak Blocking Voltage (1)	DC Gate Trigger Current In Specific Operating Quadrants V_D = 12VDC (3) (7) (15)					Peak Off-State Current Gate Open V_{DRM} = Max Rated Value (1) (16)			DC Gate Trigger Voltage V_D = 12VDC (2) (6) (15) (18)	
				Volts	mAmps					mAmps			Volts	
					QI	QII	QIII	QIV	QIV	T_C = 25°C	T_C = 100°C	T_C = 125°C	T_C = 125°C	T_C = 25°C
MAX	See "Package Dimensions" section for variations.			MIN	MAX				TYP	MAX			MIN	MAX
10.0 Amps	Q2010L5	Q2010F51	Q2010R5	200	50	50	50		75	.05	0.5	2.0	0.2	2.5
	Q4010L5	Q4010F51	Q4010R5	400	50	50	50		75	.05	0.5	2.0	0.2	2.5
	Q5010L5	Q5010F51	Q5010R5	500	50	50	50		75	.05	0.5	2.0	0.2	2.5
	Q6010L5	Q6010F51	Q6010R5	600	50	50	50		75	.05	0.5	2.0	0.2	2.5
	Q7010L5		Q7010R5	700	50	50	50		75	.05	0.5	2.0	0.2	2.5
	Q8010L5		Q8010R5	800	50	50	50		75	0.1	0.5	2.0	0.2	2.5
15.0 Amps	Q2015L5		Q2015R5	200	50	50	50			.05	0.5	2.0	0.2	2.5
	Q4015L5		Q4015R5	400	50	50	50			.05	0.5	2.0	0.2	2.5
	Q5015L5		Q5015R5	500	50	50	50			.05	0.5	2.0	0.2	2.5
	Q6015L5		Q6015R5	600	50	50	50			.05	0.5	2.0	0.2	2.5
	Q7015L5		Q7015R5	700	50	50	50			0.1	1.0	3.0	0.2	2.5
	Q8015L5		Q8015R5	800	50	50	50			0.1	1.0	3.0	0.2	2.5
25.0 Amps			Q2025R5	200	50	50	50			0.1	1.0	3.0	0.2	2.5
			Q4025R5	400	50	50	50			0.1	1.0	3.0	0.2	2.5
			Q5025R5	500	50	50	50			0.1	1.0	3.0	0.2	2.5
			Q6025R5	600	50	50	50			0.1	1.0	3.0	0.2	2.5
			Q7025R5	700	50	50	50			0.1	1.0	3.0	0.2	2.5
			Q8025R5	800	50	50	50			0.1	1.0	3.0	0.2	2.5

General Notes

- All measurements are made at 60 Hz with a resistive load at an ambient temperature of +25°C unless specified otherwise.
- Operating temperature range (T_J) is -65°C to +125°C for TO-92, and -40°C to +125°C for all other devices
- Storage temperature range (T_S) is -65°C to +150°C for TO-92, and -40°C to +150°C for TO-202 devices, and -40°C to +125°C for all other devices.
- Lead solder temperature is a maximum of 230°C for 10 seconds, maximum; ≥ 1/16" (1.59mm) from case
- The case temperature (T_C) is measured as shown on the dimensional outline drawings. See "Package Dimensions" section of this catalog.

Electrical Specification Notes

(1) For either polarity of MT2 with reference to MT1 terminal.
(2) For either polarity of gate voltage (V_{GT}) with reference to MT1 terminal.
(3) See Definition of Quadrants.
(4) See Figures 2.1 through 2.7 for current rating at specific operating temperature.
(5) See Figures 2.8 through 2.10 for i_T vs v_T.
(6) See Figure 2.12 for V_{GT} vs T_C.
(7) See Figure 2.11 for I_{GT} vs T_C.
(8) See Figure 2.14 for I_H vs T_C.
(9) See Figure 2.13 for surge rating with specific durations.
(10) See Figure 2.15 for t_{gt} vs I_{GT}.
(11) See package outlines for lead form configurations. When ordering special lead forming, add type number as suffix to part number.
(12) Initial on-state current = 200mA(DC) for 1-10 amp devices, 400 mA(DC) for 15 amp to 25 amp devices.
(13) See Figures 2.1 through 2.6 for maximum allowable case temperature at maximum rated current.
(14) Pulse width ≤ 10µs.
(15) R_L = 60Ω for 0.8-10 amp triacs; R_L = 30Ω for 15-25 amp triacs.
(16) T_C= T_J for test conditions in off-state.
(17) I_{GT}=500 mA for 25 amp devices.
(18) Quadrants I, II, and III only.

V_{TM}	I_H	I_{GTM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt(c)	dv/dt		tgt	I^2t	di/dt
Peak On-State Voltage at Maximum Rated RMS Current $T_C = 25^\circ C$ (1) (5)	Holding Current (DC) Gate Open (1) (8) (12)	Peak Gate Trigger Current (14)	Peak Gate Power Dissipation (14) $I_{GT} \leq I_{GTM}$	Average Gate Power Dissipa-tion	Peak One-Cycle Surge (9) (13) Amps		Critical Rate-of-Rise of Commutation Voltage at Rated V_{DRM} & $I_{T(RMS)}$ Commutating di/dt = 0.54 Rated $I_{T(RMS)}$/ms Gate Unenergized (1) (4) (13)	Critical Rate-of-Rise of Off-State Voltage at Rated V_{DRM} Gate Open (1) Volts/µSec		Gate Controlled Turn-On Time I_{GT} = 200mA 0.1µs Rise Time (10) (17)	RMS Surge (Non-Repeti-tive) On-State for Period of 8.3ms For Fusing	Maximum Rate-of-Change of On-State Current I_{GT} = 200mA with 0.1µs Rise Time
Volts	mAmps	Amps	Watts	Watts	60Hz	50Hz	Volts/µSec	T_C = 100°C	T_C = 125°C	µSec	$Amps^2Sec$	Amps/µSec
MAX	MAX						TYP	MIN		TYP		
1.6	50	1.8	20	0.5	120	100	4	350	225	3	60	70
1.6	50	1.8	20	0.5	120	100	4	350	225	3	60	70
1.6	50	1.8	20	0.5	120	100	4	300	200	3	60	70
1.6	50	1.8	20	0.5	120	100	4	300	200	3	60	70
1.6	50	1.8	20	0.5	120	100	4	250	175	3	60	70
1.6	50	1.8	20	0.5	120	100	4	250	175	3	60	70
1.6	70	2.0	20	0.5	200	167	4	400	275	4	166	100
1.6	70	2.0	20	0.5	200	167	4	400	275	4	166	100
1.6	70	2.0	20	0.5	200	167	4	350	225	4	166	100
1.6	70	2.0	20	0.5	200	167	4	350	225	4	166	100
1.6	70	2.0	20	0.5	200	167	4	300	200	4	166	100
1.6	70	2.0	20	0.5	200	167	4	300	200	4	166	100
1.8	100	2.0	20	0.5	200	167	5	400	275	4	220	100
1.8	100	2.0	20	0.5	200	167	5	400	275	4	220	100
1.8	100	2.0	20	0.5	200	167	5	350	225	4	220	100
1.8	100	2.0	20	0.5	200	167	5	350	225	4	220	100
1.8	100	2.0	20	0.5	200	167	5	300	200	4	220	100
1.8	100	2.0	20	0.5	200	167	5	300	200	4	220	100

Electrical Specifications

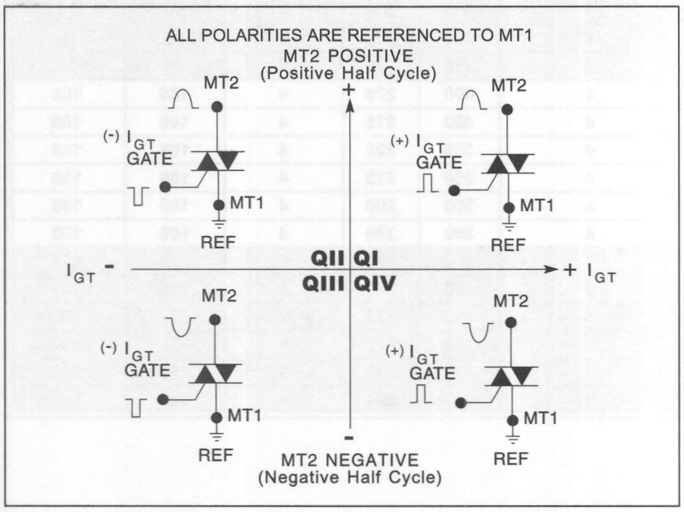
Gate Characteristics

Teccor triacs may be turned on between gate and MT1 terminals in the following ways:

- With in-phase signals (using standard AC line) Quadrants I and III are used.
- By applying unipolar pulses (gate always positive or negative)—with negative gate pulses Quadrants II and III are used and with positive gate pulses Quadrants I and IV are used.

  However, due to higher gate requirements for Quadrant IV, it is recommended that only negative pulses be applied. If positive pulses are required, see sensitive triac sections of catalog or contact factory.

In all cases, if maximum surge capability is required, pulses should be a minimum of one magnitude above I_{GT} rating with a steep rising waveform (≤ 1 µsec rise time).



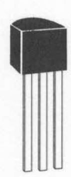
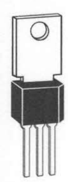
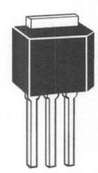
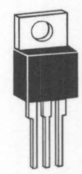
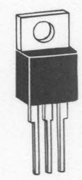
Definition of Quadrants

Electrical Isolation

Teccor's isolated triac packages will withstand a minimum high potential test of 2500VAC (RMS) from leads to mounting tab, over the operating temperature range of the device. See isolation table below for standard and optional isolation ratings.

ELECTRICAL ISOLATION FROM LEADS TO MOUNTING TAB	
VAC (RMS)	Isolated ** TO-220AB
2500	Standard
4000	Optional *

* For 4000V isolation, use V suffix in part number.
** UL Recognized File E71639

THERMAL RESISTANCE (STEADY STATE) $R_{\theta JC}$ $[R_{\theta JA}]$ (TYP.) °C/W					
Type	 TO-92	 TYPE 1 TO-202AB	 TYPE 2 TO-202AB	 THERMOTAB TO-220AB	 NON-ISOLATED TO-220AB
0.8 Amp	60 [135]				
1.0 Amp	50 [95]				
4.0 Amps		3.5 [45]	6 [70]	3.6 [50]	
6.0 Amps		3.8		3.3	2.1 [45]
8.0 Amps		3.3		2.8	1.8
10.0 Amps		3.5		2.6	1.5
15.0 Amps				2.1	1.3
25.0 Amps					1.1

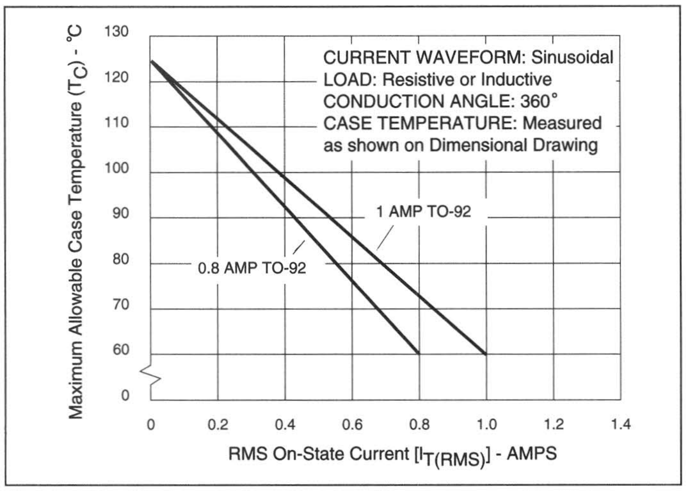


Figure 2.1 Maximum Allowable Case Temperature vs On-State Current (0.8 and 1.0 Amp)

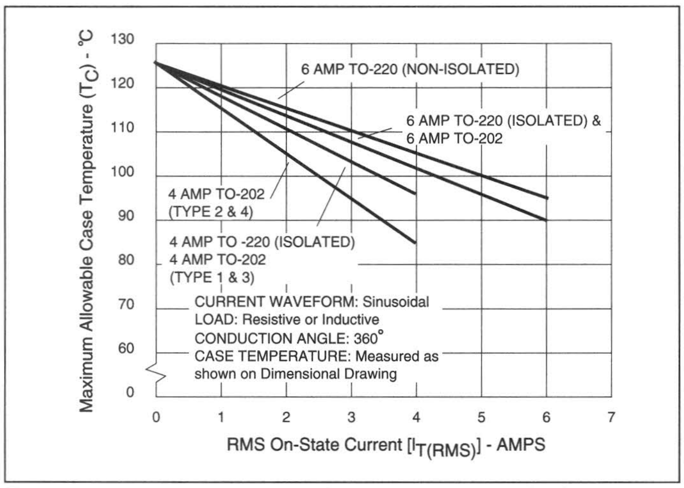


Figure 2.2 Maximum Allowable Case Temperature vs On-State Current (4 and 6 Amp)

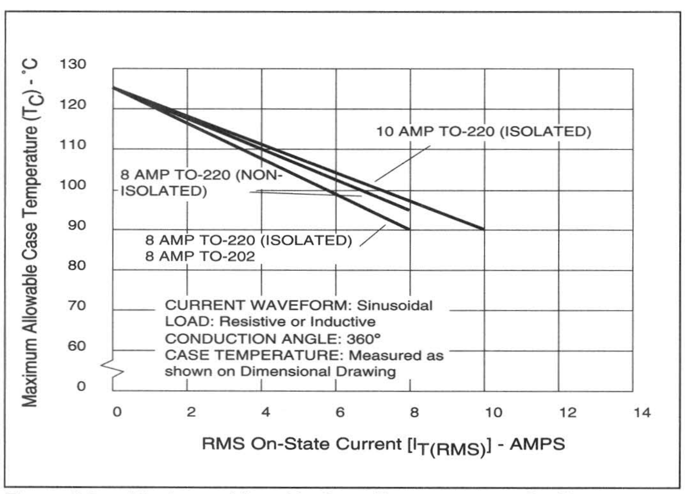


Figure 2.3 Maximum Allowable Case Temperature vs On-State Current (8 and 10 Amp)

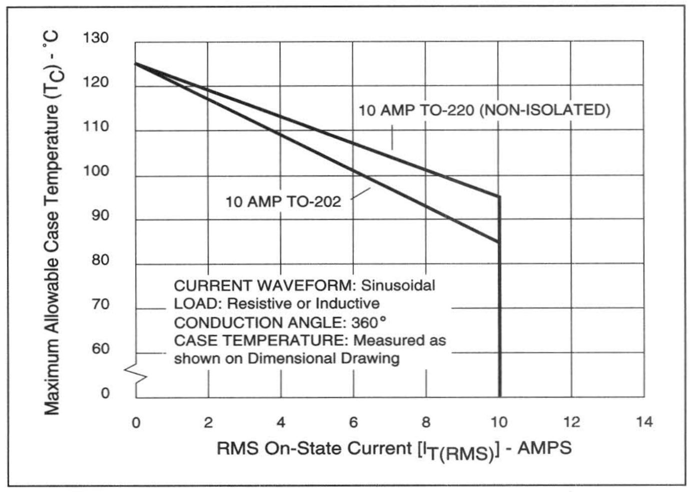


Figure 2.4 Maximum Allowable Case Temperature vs On-State Current (10 Amp)

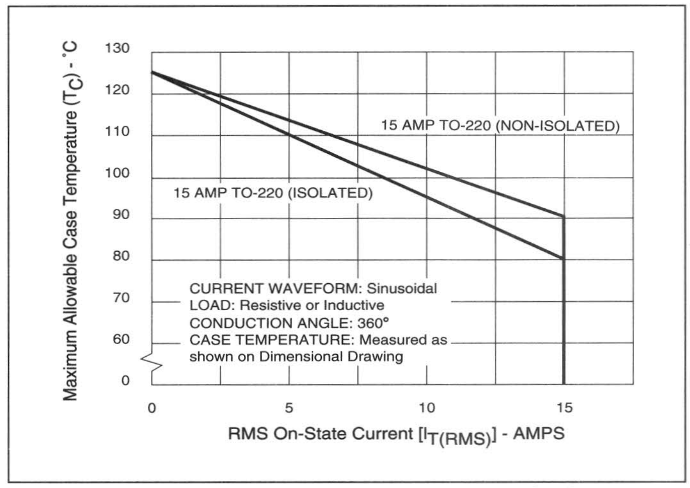


Figure 2.5 Maximum Allowable Case Temperature vs On-State Current (15 Amp)

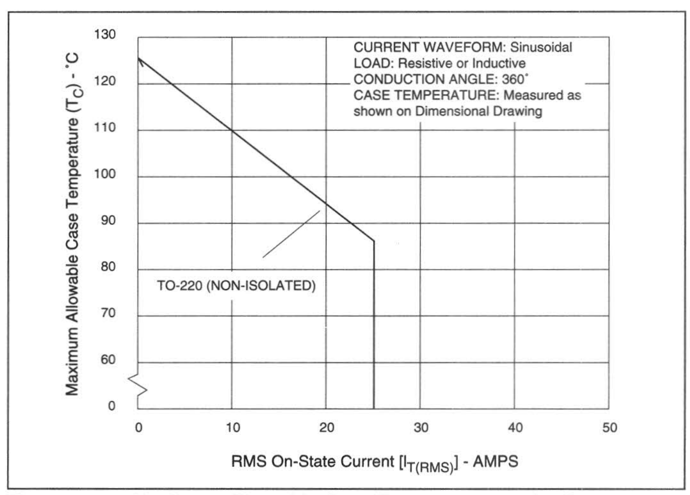


Figure 2.6 Maximum Allowable Case Temperature vs On-State Current (25 Amp)

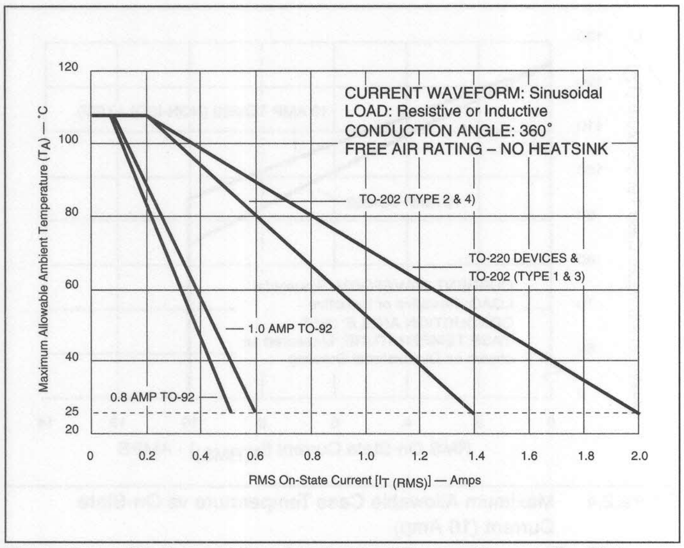


Figure 2.7 Maximum Allowable Ambient Temperature vs On-State Current

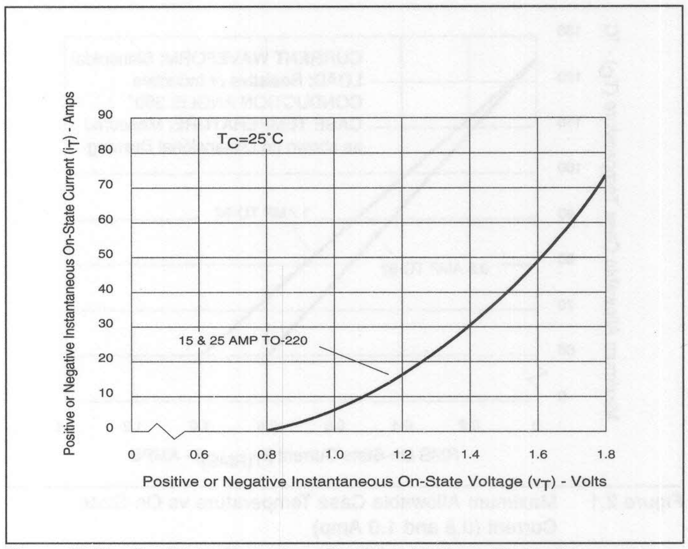


Figure 2.10 On-State Current vs On-State Voltage (Typical) (15 and 25 Amp)

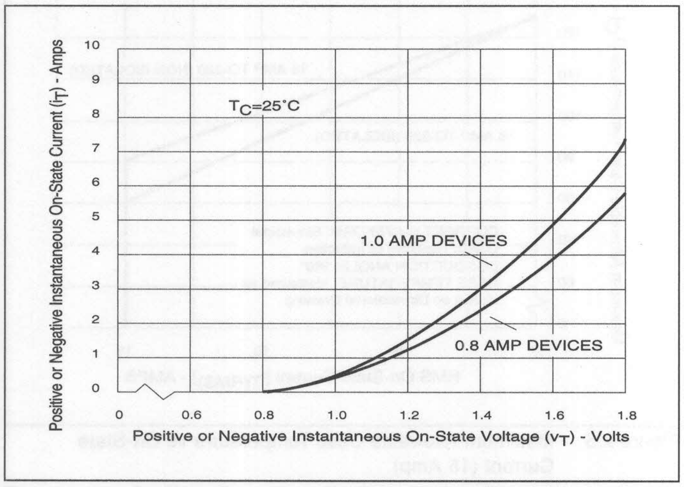


Figure 2.8 On-State Current vs On-State Voltage (Typical) (0.8 and 1.0 Amp)

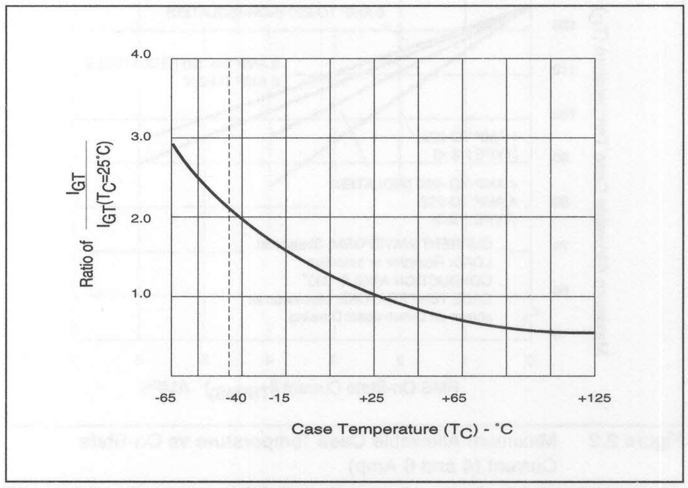


Figure 2.11 Normalized DC Gate Trigger Current for All Quadrants vs Case Temperature

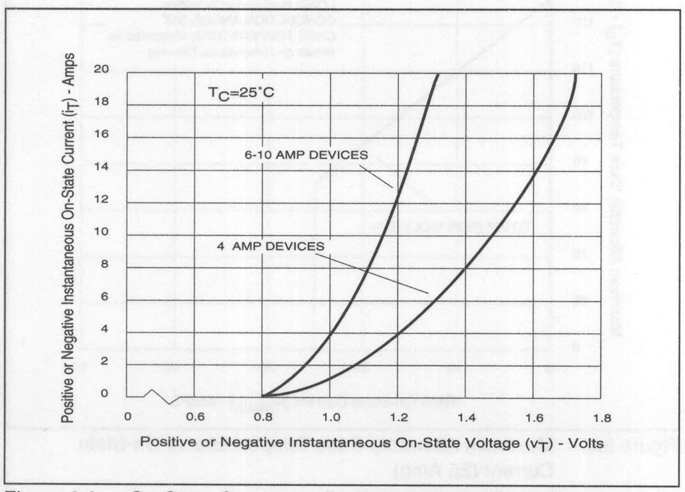


Figure 2.9 On-State Current vs On-State Voltage (Typical) (4, 6, 8, and 10 Amp)

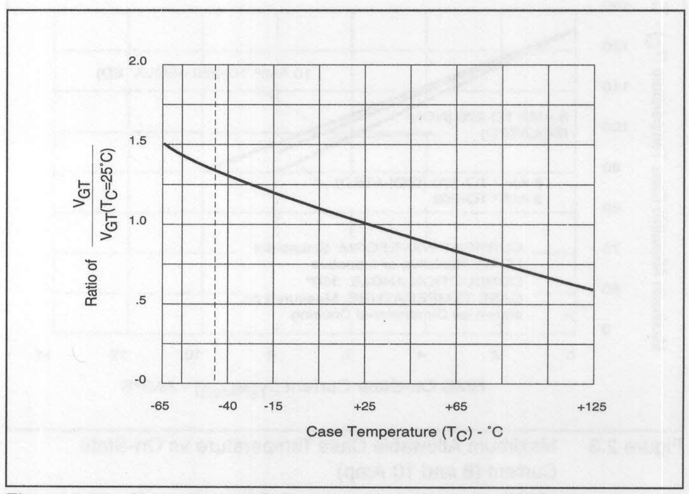


Figure 2.12 Normalized DC Gate Trigger Voltage for All Quadrants vs Case Temperature

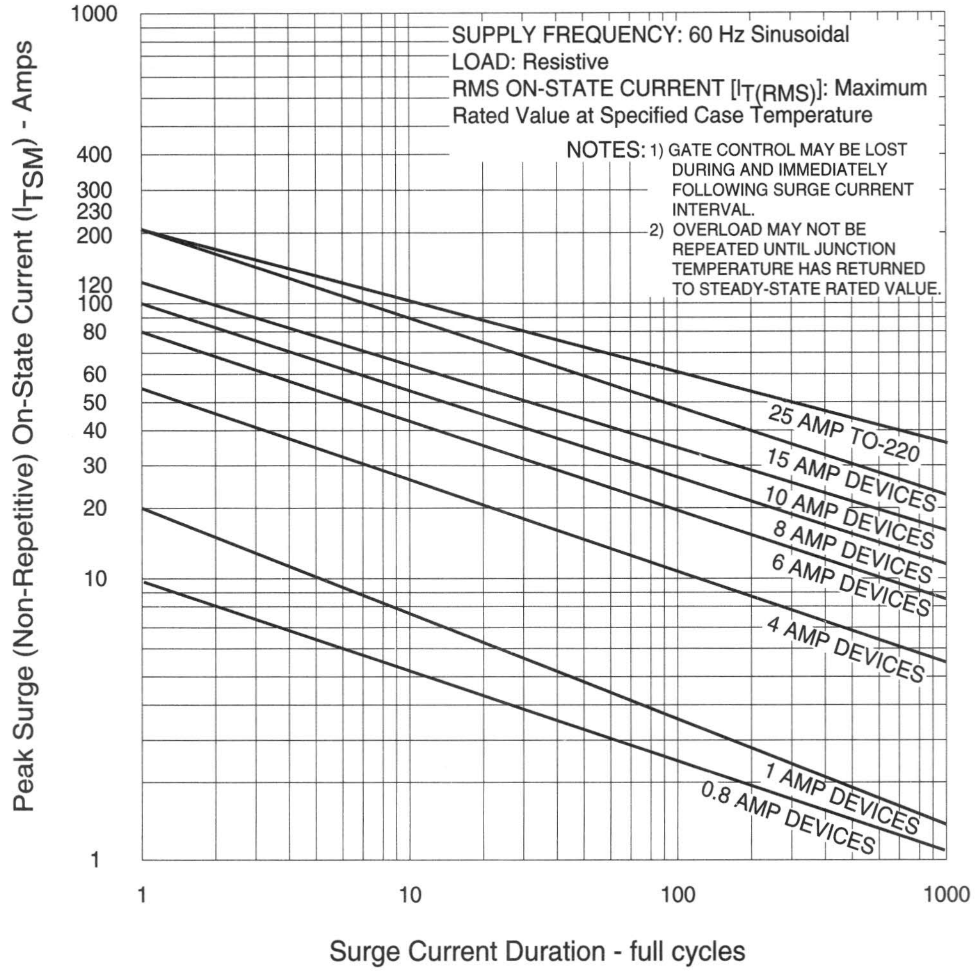


Figure 2.13 Peak Surge Current vs Surge Current Duration

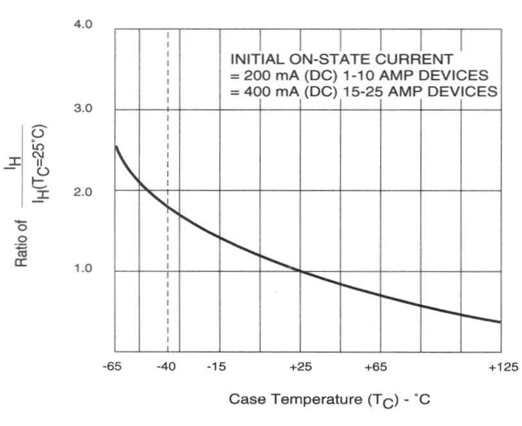


Figure 2.14 Normalized DC Holding Current vs Case Temperature

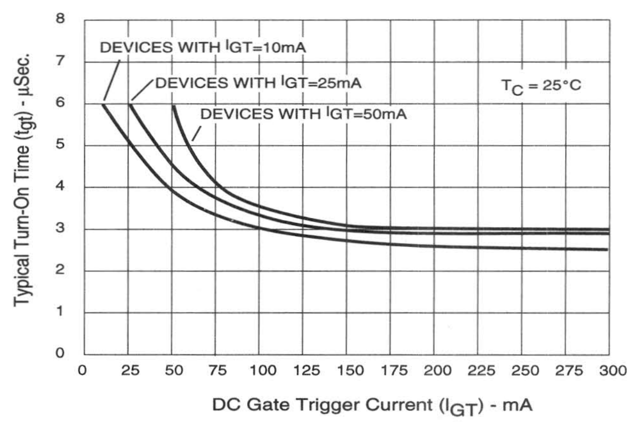


Figure 2.15 Turn-On Time vs Gate Trigger Current (Typical)

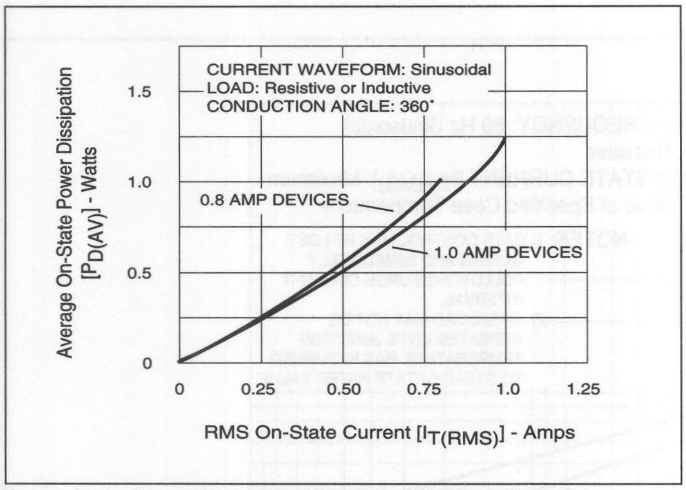


Figure 2.16 Power Dissipation (Typical) vs On-State Current (0.8 and 1.0 Amp)

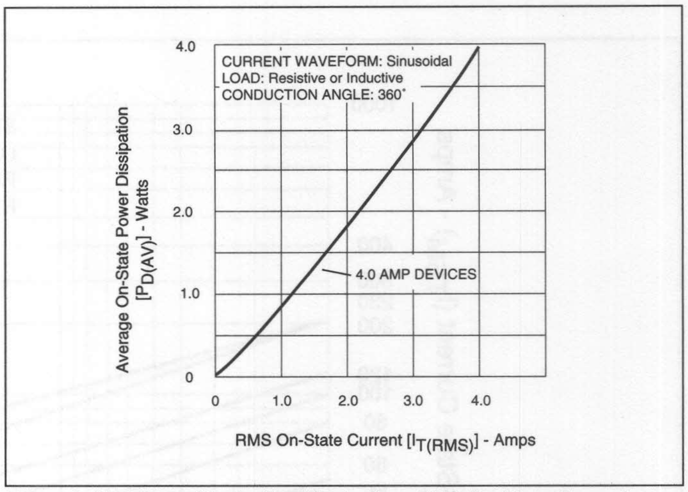


Figure 2.19 Power Dissipation (Typical) vs RMS On-State Current (4 Amp)

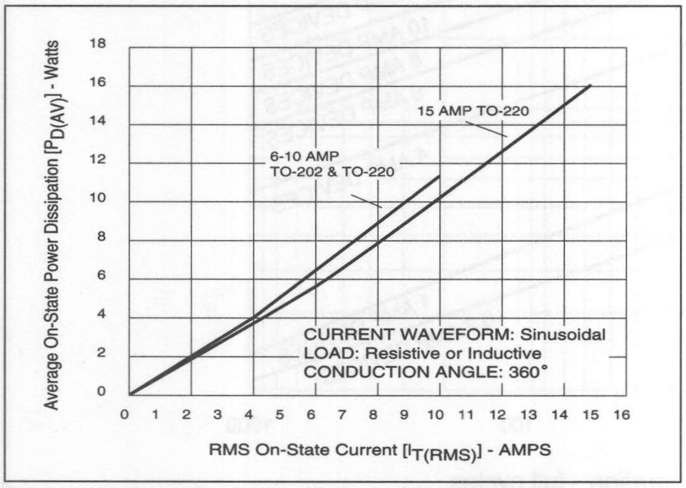


Figure 2.17 Power Dissipation (Typical) vs On-State Current (6-10 and 15 Amp)

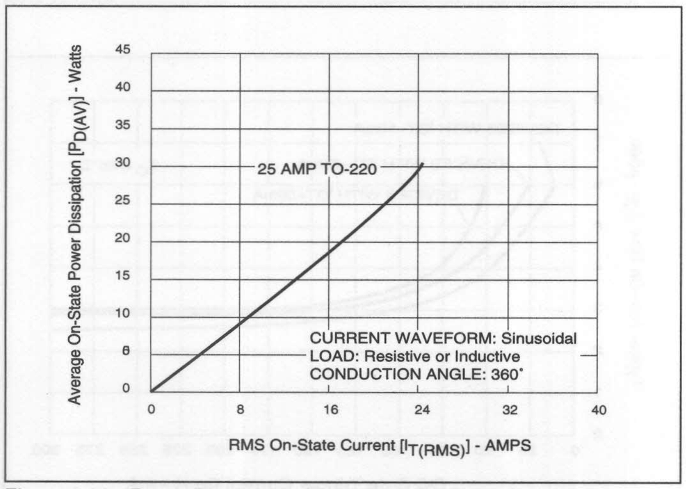
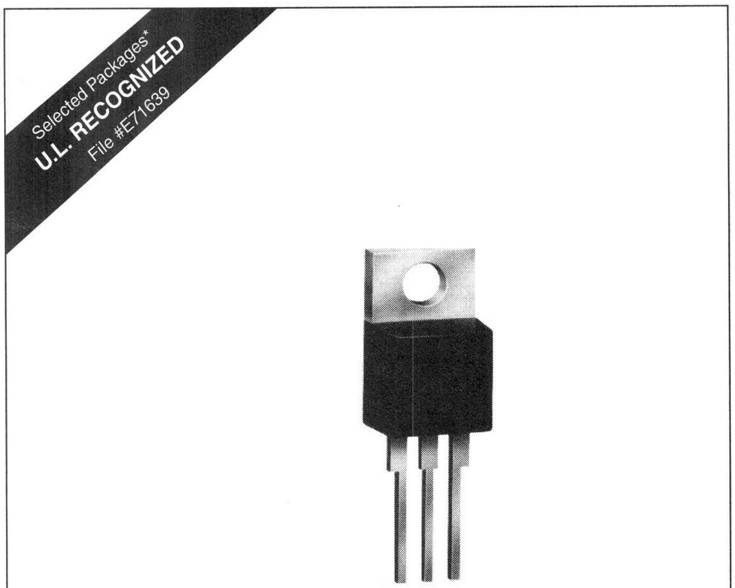
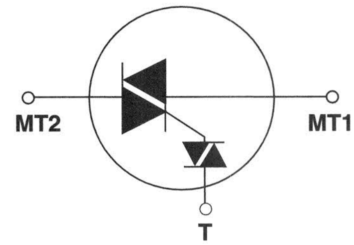


Figure 2.18 Power Dissipation (Typical) vs On-State Current (25 Amp)



THERMOTAB
TO-220AB
(Isolated)



QUADRACs

Internally Triggered Triacs (4 – 15 Amps)

General Description

Teccor's QUADRAC is a triac that includes a diac trigger mounted inside the same package. This device, developed by Teccor, saves the user the expense and assembly time of buying a discrete diac and assembling in conjunction with a gated triac.

The QUADRAC is a bidirectional AC switch and is gate controlled for either polarity of main terminal voltage. Its primary purpose is for AC switching and phase control applications such as speed controls, temperature modulation controls, and lighting controls.

Triac current capacities range from 4 to 15 Amperes with voltage ranges from 200-600 Volts. QUADRACs are available in the TO-220AB package as shown above.

The Thermotab package is electrically isolated to 2,500 V (RMS) from the leads to mounting surface. 4,000 V (RMS) available on special order. This means that no external isolation is required, thus eliminating the need for separate insulators and insulator-mounting steps ... saving dollars over "hot tab" devices.

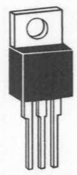
All Teccor triac and diac chips have glass-passivated junctions to ensure long term device reliability and parameter stability.

Variations of devices in this data sheet are available for custom design applications. Please consult the factory for more information.

Features

- **Glass-passivated junctions**
- **Electrically-isolated package**
- **Internal trigger diac**
- **High surge capability — up to 200 Amps**
- **High voltage capability — 200 up to 600 Volts**

Electrical Specifications

$I_{T(RMS)}$	Part No. Isolated	V_{DRM}	I_{DRM}			V_{TM}	Trigger Diac Specifications (T–MT1)					
							ΔV_{BO}	V_{BO}		[ΔV±]	I_{BO}	C_T
RMS On-State Current Conduction Angle of 360° (5)	 THERMOTAB TO-220AB	Repetitive Peak Blocking Voltage (1)	Peak Off-State Current Gate Open V_{DRM} = Max Rated Value (1) (10) mAmps			Peak On-State Voltage at Max Rated RMS Current $T_C = 25^\circ C$ (1) (3)	Breakover Voltage Symmetry (7)	Breakover Voltage (Forward & Reverse) (6)		Dynamic Breakback Voltage (Forward & Reverse) (6)	Peak Break-over Current	Trigger Firing Capaci-tance (11)
		Volts	T_C = 25˚C	T_C = 100˚C	T_C = 125˚C	Volts	Volts	Volts		Volts	µAmps	µFarads
See "Package Dimensions" section for variations.		MIN	MAX			MAX	MAX	MIN	MAX	MIN	MAX	MAX
4.0 Amps	Q2004LT	200	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q4004LT	400	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q5004LT	500	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q6004LT	600	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
6.0 Amps	Q2006LT	200	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q4006LT	400	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q5006LT	500	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q6006LT	600	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
8.0 Amps	Q2008LT	200	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q4008LT	400	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q5008LT	500	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q6008LT	600	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
10.0 Amps	Q2010LT	200	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q4010LT	400	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q5010LT	500	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q6010LT	600	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
15.0 Amps	Q2015LT	200	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q4015LT	400	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q5015LT	500	.05	0.5	2.0	1.6	3	33	43	5	25	0.1
	Q6015LT	600	.05	0.5	2.0	1.6	3	33	43	5	25	0.1

General Notes

- All measurements are made at 60Hz with resistive load at an ambient temperature of +25°C unless otherwise specified.
- Operating temperature range (T_J) is -40°C to +125°C.
- Storage temperature range (T_S) is -40°C to +125°C.
- Lead solder temperature is a maximum of +230°C for 10 seconds maximum; ≥ 1/16" (1.59mm) from case.
- The case temperature (T_C) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.

Electrical Specification Notes

(1) For either polarity of MT2 with reference to MT1.
(2) See Figure 3.1 for I_H vs T_C.
(3) See Figures 3.4 and 3.5 for i_T vs v_T.
(4) See Figure 3.9 for surge ratings with specific durations.
(5) See Figures 3.6, 3.7, and 3.8 for current rating at specific operating temperature.
(6) See Figures 3.2 and 3.3 for test circuit.
(7) $\Delta V_{BO} = [+ V_{BO}] - [- V_{BO}]$
(8) See Figures 3.7 and 3.8 for maximum allowable case temperature at maximum rated current.
(9) Trigger firing capacitance = 0.1µF with 0.1µs rise time.
(10) $T_C = T_J$ for test conditions in off-state.
(11) Maximum required value to ensure sufficient gate current.

THERMAL RESISTANCE (STEADY STATE) $R_{\theta JC}$ [$R_{\theta JA(TYP)}$] ˚C/WATT	
TYPE	ISOLATED TO-220AB
4.0 Amps	3.6 [50]
6.0 Amps	3.3
8.0 Amps	2.8
10.0 Amps	2.6
15.0 Amps	2.1

Electrical Isolation

All Teccor isolated QUADRAC packages will withstand a minimum high potential test of 2500VAC (RMS) from leads to mounting tab over the operating temperature range of the device. See isolation table for standard and optional isolation ratings.

ELECTRICAL ISOLATION FROM LEADS TO MOUNTING TAB **	
VAC(RMS)	TYPE
2500	Standard
4000	Optional*

* For 4000 V isolation use "V" suffix.
** U.L. Recognized File #E71639

I_H	I_{TSM}		dv/dt(c)	dv/dt		t_{gt}	I^2t	I_{GTM}	di/dt
Holding Current Gate Open (1) (2)	Peak One Cycle Surge (4) (8)		Critical Rate-of-Rise of Commutation Voltage at Rated V_{DRM} and $I_{T(RMS)}$ Commutating di/dt = 0.54 Rated $I_{T(RMS)}$/ms Gate Unenergized (1) (5) (8)	Critical Rate-of-Rise of Off-State Voltage at Rated V_{DRM} Gate Open (1) Volts/µSec		Gate Controlled Turn-On Time (6) (9)	RMS Surge (Non-Repetitive) On-State Current for period of 8.3ms for Fusing	Peak Gate Trigger Current (10µs Max)	Maximum Rate-of-Change of On-State Current (9)
mAmps	Amps		Volts/µSec	T_C = 100˚C	T_C = 125˚C	µSec	$Amps^2Sec$	Amps	Amps/µSec
MAX	60Hz	50Hz	MIN	MIN		TYP			
40	55	46	3	75	50	3	12.5	1.2	50
40	55	46	3	75	50	3	12.5	1.2	50
40	55	46	3	50	50	3	12.5	1.2	50
40	55	46	3	50	50	3	12.5	1.2	50
50	80	65	4	150	100	3	26.5	1.5	70
50	80	65	4	150	100	3	26.5	1.5	70
50	80	65	4	125	85	3	26.5	1.5	70
50	80	65	4	125	85	3	26.5	1.5	70
60	100	83	4	175	120	3	41	1.5	70
60	100	83	4	175	120	3	41	1.5	70
60	100	83	4	150	100	3	41	1.5	70
60	100	83	4	150	100	3	41	1.5	70
60	120	100	4	200	150	3	60	1.5	70
60	120	100	4	200	150	3	60	1.5	70
60	120	100	4	175	120	3	60	1.5	70
60	120	100	4	175	120	3	60	1.5	70
70	200	167	4	300	200	3	166	1.5	100
70	200	167	4	300	200	3	166	1.5	100
70	200	167	4	200	150	3	166	1.5	100
70	200	167	4	200	150	3	166	1.5	100

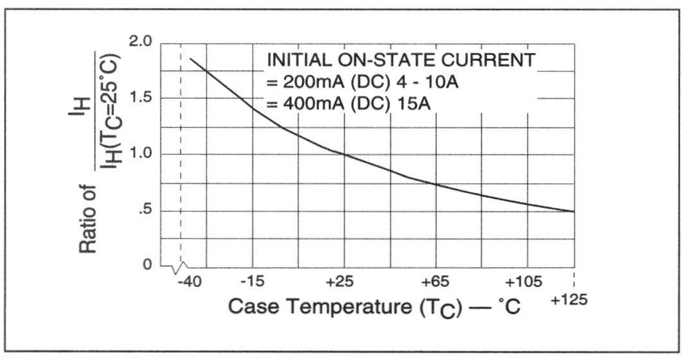


Figure 3.1 Normalized DC Holding Current vs Case Temperature

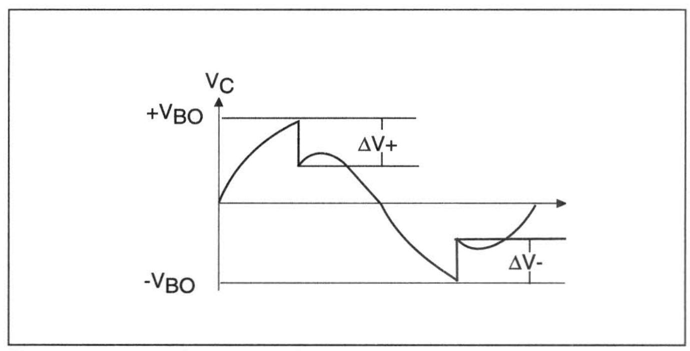


Figure 3.3 Test Circuit Waveforms

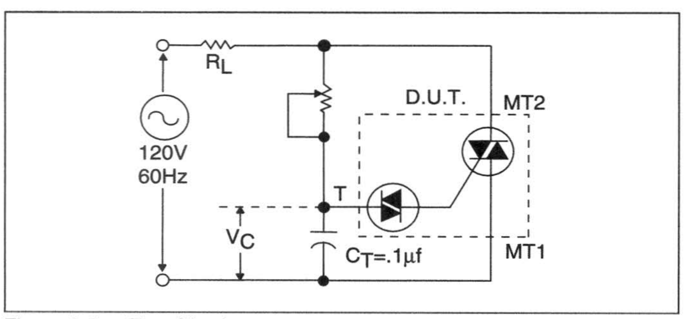


Figure 3.2 Test Circuit

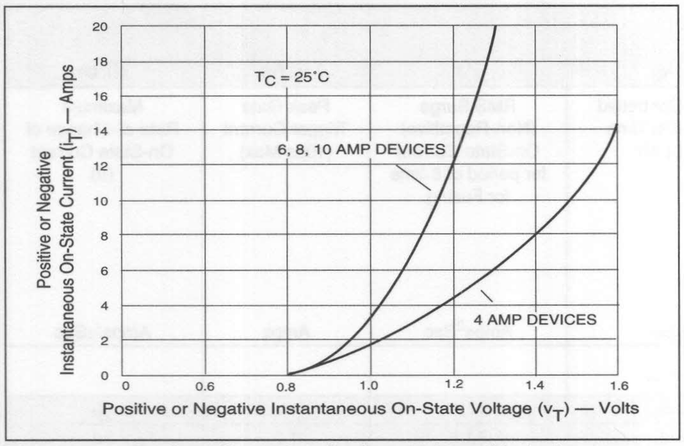


Figure 3.4 On-State Current vs On-State Voltage (Typical) (4-10 Amp)

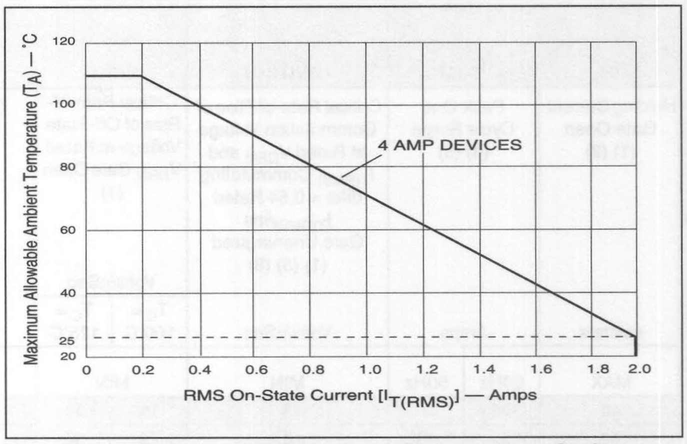


Figure 3.6 Maximum Allowable Ambient Temperature vs On-State Current

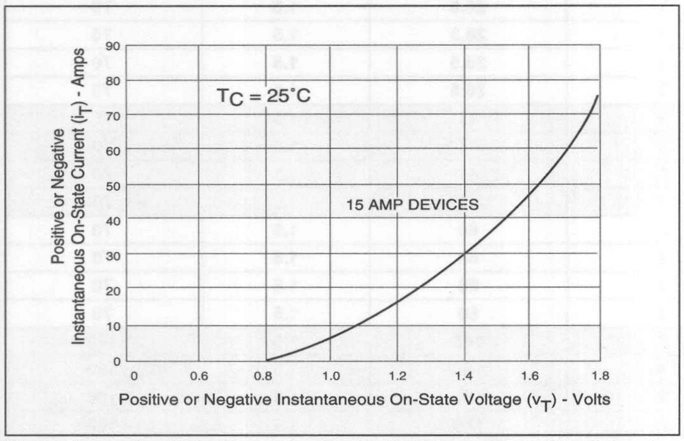


Figure 3.5 On-State Current vs On-State Voltage (Typical) (15 Amp)

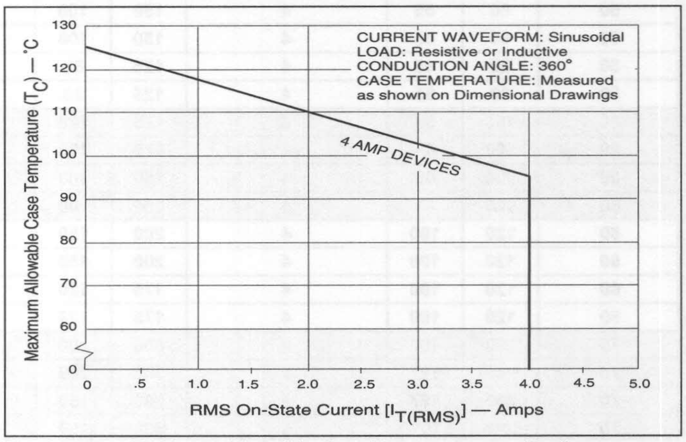


Figure 3.7 Maximum Allowable Case Temperature vs On-State Current (4 Amp)

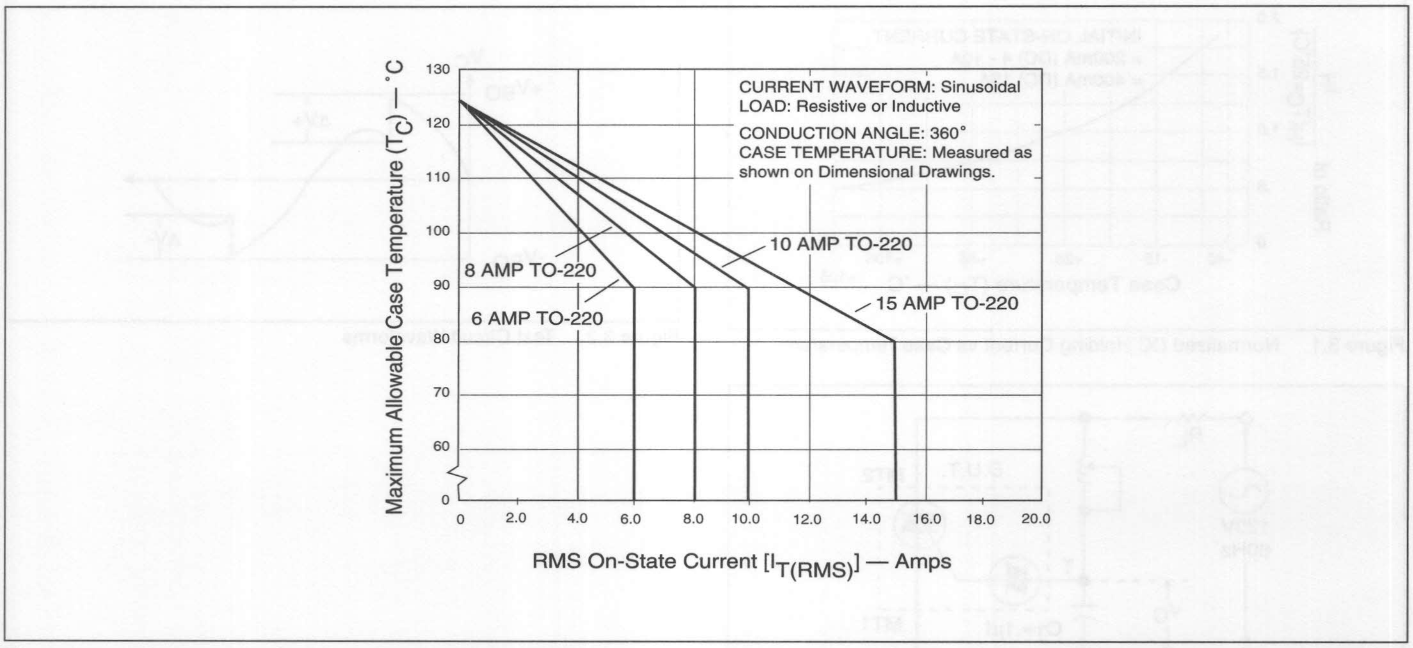


Figure 3.8 Maximum Allowable Case Temperature vs On-State Current (6-15 Amp)

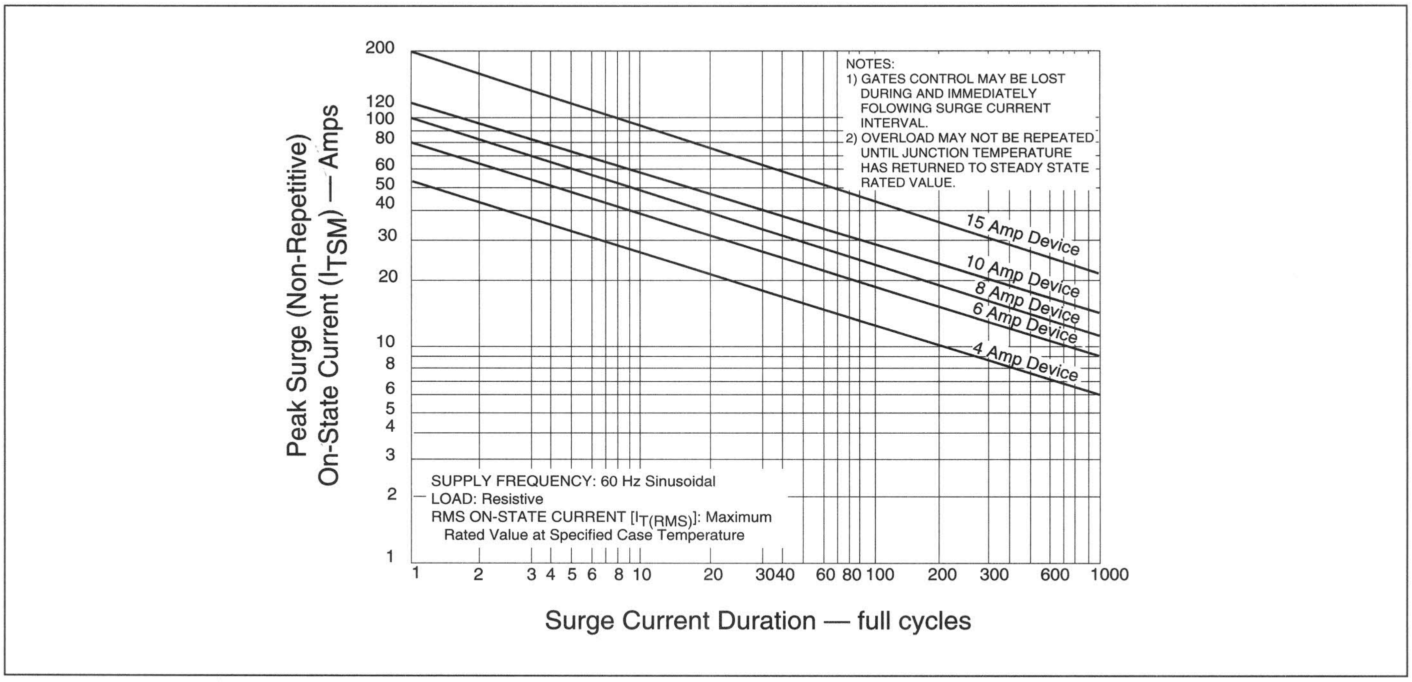


Figure 3.9 Peak Surge Current vs Surge Current Duration

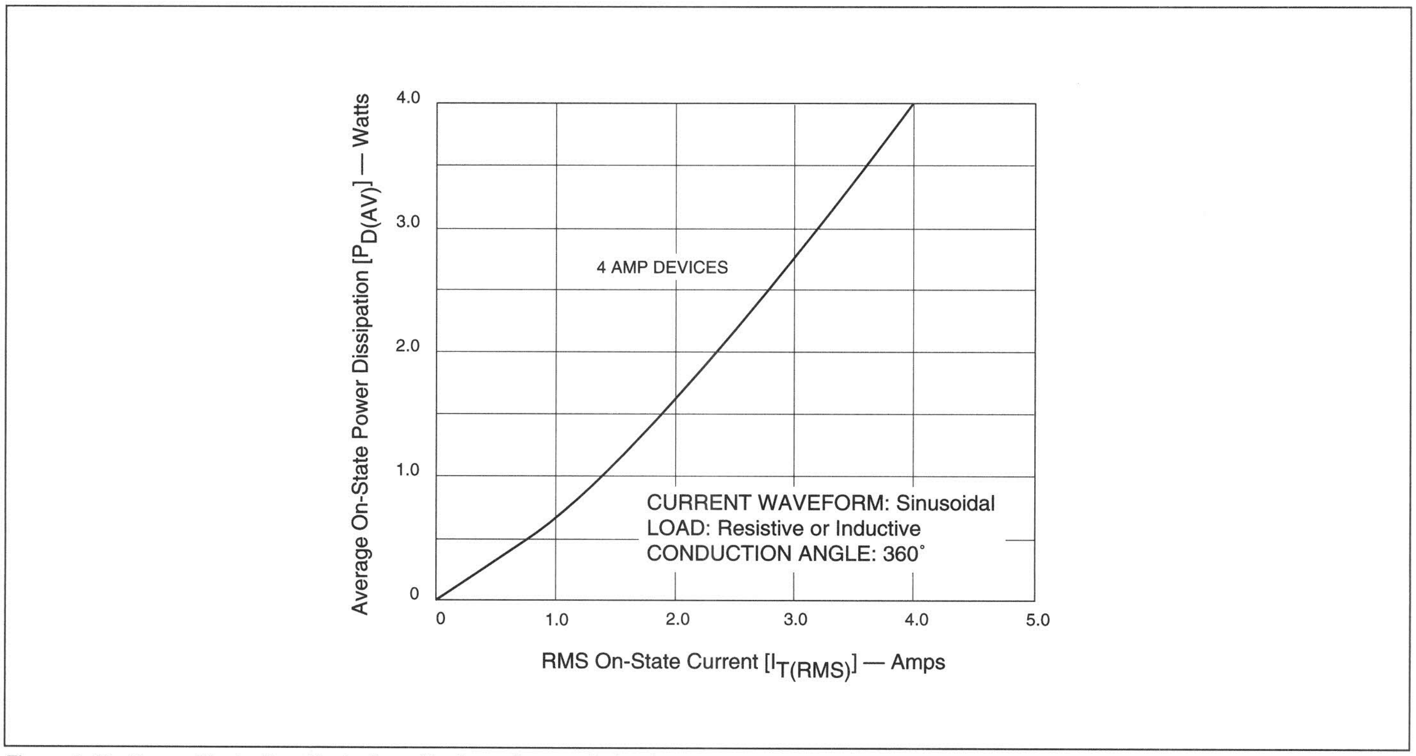


Figure 3.10 Power Dissipation (Typical) vs. On-State Current (4 Amp)

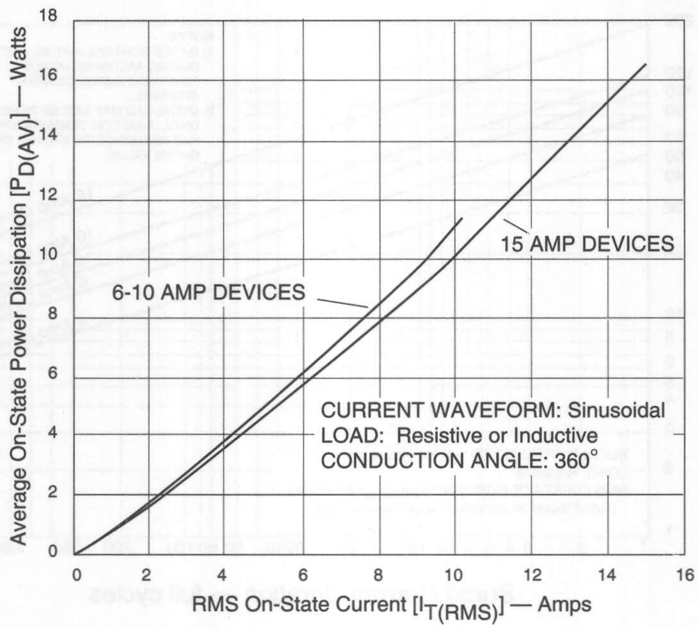
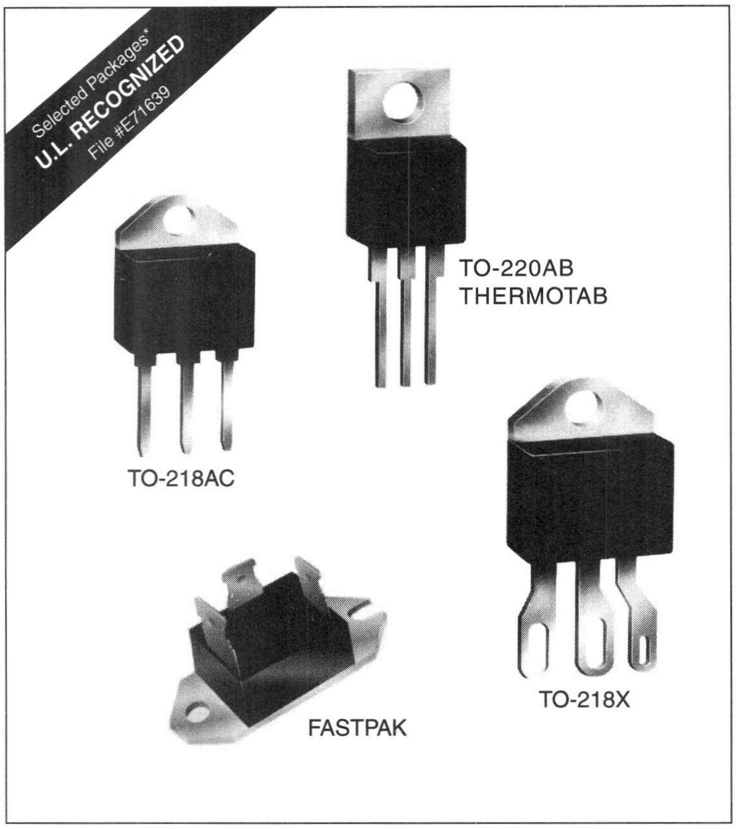
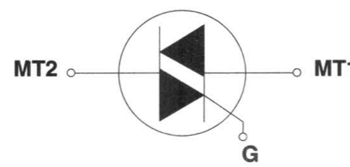


Figure 3.11 Power Dissipation (Typical) vs. On-State Current (6-10 and 15 Amp)





Alternistor Triacs

(6 – 40 Amps)

General Description

Teccor offers bidirectional alternistors with current ratings from 6 to 40 amperes with voltages from 200 to 800 volts as part of Teccor's broad line of thyristors. Teccor's alternistor has been specifically designed for applications which are required to switch highly inductive loads. To accomplish this, a special chip has been designed which effectively offers the same performance as two thyristors (SCRs) wired inverse parallel (back-to-back); hence, the alternistor has better turn-off behavior than a standard triac. An alternistor may be triggered from a blocking to conduction state for either polarity of applied AC voltage with operating modes in Quadrants I, II, and III.

This new chip construction provides two electrically separate SCR structures, providing enhanced dv/dt characteristics while retaining the advantages of a single chip device.

All alternistors have glass-passivated junctions to ensure long term reliability and parameter stability. Teccor's glass offers a reliable barrier against junction contamination.

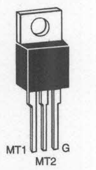
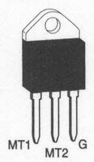
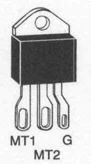
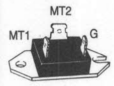
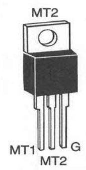
These alternistors are offered in four basic package configurations: TO-218X, TO-218AC, FastPak, and TO-220AB. Teccor's TO-218X package has been designed for heavy, steady power-handling capability. The TO-218X features large eyelet terminals for ease of soldering heavy gauge hook-up wire. All the isolated packages have a standard isolation voltage rating of $2500V_{RMS}$.

Variations of devices covered in this data sheet are available for custom design applications. Please consult factory for further information.

Features

- **High surge current capability**
- **Glass-passivated junctions**
- **2500VAC isolation for "L," "J," "P," and "K"**
- **High commutating dv/dt**
- **High static dv/dt**

Electrical Specifications

$I_{T(RMS)}$	Part Number					V_{DRM}	I_{GT}			I_{DRM}			V_{GT}	
	Isolated				Non-Isolated									
RMS On-State Current Conduction Angle of 360° (4)(16)	 THERMOTAB T0-220AB	 TO-218AC (16)	 TO-218X	 FASTPAK TO-3 BASE	 TO-220AB	Repetitive Peak Blocking Voltage (1)	DC Gate Trigger Current in Specific Operating Quadrants $V_{D=12VDC}$ (3) (7) (15) (17)			Peak Off-State Current Gate Open V_{DRM}=Max Rated Value (1) (18)			DC Gate Trigger Voltage V_D=12VDC (2) (6) (15) (17)	
							mAmps			mAmps			Volts	
						Volts	QI	QII	QIII	T_C = 25°C	T_C = 100°C	T_C = 125°C	T_C = 125°C	T_C = 25°C
MAX	See "Package Dimensions" section for variations. (11)					MIN	MAX			MAX			MIN	MAX
6 Amps	Q2006LH4				Q2006RH4	200	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q4006LH4				Q4006RH4	400	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q5006LH4				Q5006RH4	500	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q6006LH4				Q6006RH4	600	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q7006LH4				Q7006RH4	700	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q8006LH4				Q8006RH4	800	35	35	35	0.01	0.5	2.0	0.2	1.5
8 Amps	Q2008LH4				Q2008RH4	200	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q4008LH4				Q4008RH4	400	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q5008LH4				Q5008RH4	500	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q6008LH4				Q6008RH4	600	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q7008LH4				Q7008RH4	700	35	35	35	0.01	0.5	2.0	0.2	1.5
	Q8008LH4				Q8008RH4	800	35	35	35	0.01	0.5	2.0	0.2	1.5
10 Amps	Q2010LH5				Q2010RH5	200	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q4010LH5				Q4010RH5	400	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q5010LH5				Q5010RH5	500	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q6010LH5				Q6010RH5	600	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q7010LH5				Q7010RH5	700	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q8010LH5				Q8010RH5	800	50	50	50	0.01	0.5	2.0	0.2	1.5
12 Amps	Q2012LH5				Q2012RH5	200	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q4012LH5				Q4012RH5	400	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q5012LH5				Q5012RH5	500	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q6012LH5				Q6012RH5	600	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q7012LH5				Q7012RH5	700	50	50	50	0.01	0.5	2.0	0.2	1.5
	Q8012LH5				Q8012RH5	800	50	50	50	0.01	0.5	2.0	0.2	1.5
15 Amps	Q2015L6				Q2015R6	200	80	80	80	.05	0.5	2.0	0.2	2.5
	Q4015L6				Q4015R6	400	80	80	80	.05	0.5	2.0	0.2	2.5
	Q5015L6				Q5015R6	500	80	80	80	.05	0.5	2.0	0.2	2.5
	Q6015L6				Q6015R6	600	80	80	80	.05	0.5	2.0	0.2	2.5
	Q7015L6				Q7015R6	700	80	80	80	0.1	1.0	3.0	0.2	2.5
	Q8015L6				Q8015R6	800	80	80	80	0.1	1.0	3.0	0.2	2.5
25 Amps	Q2025L6	Q2025K6	Q2025J6	Q2025P	Q2025R6	200	80	80	80	.05	0.5	2.0	0.2	2.5
	Q4025L6	Q4025K6	Q4025J6	Q4025P	Q4025R6	400	80	80	80	.05	0.5	2.0	0.2	2.5
	Q5025L6	Q5025K6	Q5025J6	Q5025P	Q5025R6	500	80	80	80	.05	0.5	2.0	0.2	2.5
	Q6025L6	Q6025K6	Q6025J6	Q6025P	Q6025R6	600	80	80	80	.05	0.5	2.0	0.2	2.5
	Q7025L6	Q7025K6	Q7025J6	Q7025P	Q7025R6	700	80	80	80	0.1	1.0	3.0	0.2	2.5
	Q8025L6	Q8025K6	Q8025J6	Q8025P	Q8025R6	800	80	80	80	0.1	1.0	3.0	0.2	2.5
40 Amps		Q2040K7	Q2040J7	Q2040P		200	100	100	100	0.2	2.0	5.0	0.2	2.5
		Q4040K7	Q4040J7	Q4040P		400	100	100	100	0.2	2.0	5.0	0.2	2.5
		Q5040K7	Q5040J7	Q5040P		500	100	100	100	0.2	2.0	5.0	0.2	2.5
		Q6040K7	Q6040J7	Q6040P		600	100	100	100	0.2	2.0	5.0	0.2	2.5
		Q7040K7	Q7040J7	Q7040P		700	100	100	100	0.2	2.0	5.0	0.2	2.5
		Q8040K7	Q8040J7			800	100	100	100	0.2	2.0	5.0	0.2	2.5

See General Notes and Electrical Specification Notes on page 4-4.

V_{TM}	I_H	I_{GTM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt (c)	dv/dt		tgt	I^2t	di/dt
Peak On-State Voltage at Max Rated RMS Current $T_C = 25°C$ (1) (5)	Holding Current (DC) Gate Open (1) (8) (12)	Peak Gate Trigger Current (14)	Peak Gate Power Dissipation (14) $I_{GT} \leq I_{GTM}$	Average Gate Power Dissipation	Peak One Cycle Surge (9) (13) Amps		Critical Rate-of-Rise of Commutation Voltage at Rated V_{DRM} and $I_{T(RMS)}$ Commutating di/dt = 0.54 Rated $I_{T(RMS)}$/ms Gate Unenergized (1) (4) (13)	Critical Rate-of-Rise of Off-State Voltage at Rated V_{DRM} Gate Open (1) Volts/μSec		Gate Controlled Turn-On Time I_{GT} = 300mA 0.1μs Rise Time (10)	RMS Surge (Non-Repetitive) On-State Current for period of 8.3 ms for Fusing	Maximum Rate -of-Change of On-State Current (19)
Volts	mAmps	Amps	Watts	Watts	60Hz	50Hz	Volts/μSec	T_C = 100°C	T_C = 125°C	μSec	$Amps^2Sec$	Amps/μSec
MAX	MAX						MIN	MIN		TYP		
1.6	35	1.6	18	0.5	65	60	20	750	600	4	17.5	70
1.6	35	1.6	18	0.5	65	60	20	575	450	4	17.5	70
1.6	35	1.6	18	0.5	65	60	20	500	400	4	17.5	70
1.6	35	1.6	18	0.5	65	60	20	425	350	4	17.5	70
1.6	35	1.6	18	0.5	65	60	20	375	300	4	17.5	70
1.6	35	1.6	18	0.5	65	60	20	300	250	4	17.5	70
1.6	35	2.0	20	0.5	85	80	25	750	600	4	30	70
1.6	35	2.0	20	0.5	85	80	25	575	450	4	30	70
1.6	35	2.0	20	0.5	85	80	25	500	400	4	30	70
1.6	35	2.0	20	0.5	85	80	25	425	350	4	30	70
1.6	35	2.0	20	0.5	85	80	25	375	300	4	30	70
1.6	35	2.0	20	0.5	85	80	25	300	250	4	30	70
1.6	50	2.0	20	0.5	110	100	30	1150	1000	4	50	70
1.6	50	2.0	20	0.5	110	100	30	1000	750	4	50	70
1.6	50	2.0	20	0.5	110	100	30	925	700	4	50	70
1.6	50	2.0	20	0.5	110	100	30	850	650	4	50	70
1.6	50	2.0	20	0.5	110	100	30	775	600	4	50	70
1.6	50	2.0	20	0.5	110	100	30	650	500	4	50	70
1.6	50	2.0	20	0.5	120	110	30	1150	1000	4	60	70
1.6	50	2.0	20	0.5	120	110	30	1000	750	4	60	70
1.6	50	2.0	20	0.5	120	110	30	925	700	4	60	70
1.6	50	2.0	20	0.5	120	110	30	850	650	4	60	70
1.6	50	2.0	20	0.5	120	110	30	775	600	4	60	70
1.6	50	2.0	20	0.5	120	110	30	650	500	4	60	70
1.6	70	2.0	20	0.5	200	167	30	875	600	5	166	100
1.6	70	2.0	20	0.5	200	167	30	875	600	5	166	100
1.6	70	2.0	20	0.5	200	167	30	800	520	5	166	100
1.6	70	2.0	20	0.5	200	167	30	800	520	5	166	100
1.6	70	2.0	20	0.5	200	167	30	700	475	5	166	100
1.6	70	2.0	20	0.5	200	167	30	700	475	5	166	100
1.8	100	2.0	20	0.5	250	208	30	875	600	5	259	100
1.8	100	2.0	20	0.5	250	208	30	875	600	5	259	100
1.8	100	2.0	20	0.5	250	208	30	800	520	5	259	100
1.8	100	2.0	20	0.5	250	208	30	800	520	5	259	100
1.8	100	2.0	20	0.5	250	208	30	700	475	5	259	100
1.8	100	2.0	20	0.5	250	208	30	700	475	5	259	100
1.8	120	4.0	40	0.8	400	335	50	1100	700	5	664	150
1.8	120	4.0	40	0.8	400	335	50	1100	700	5	664	150
1.8	120	4.0	40	0.8	400	335	50	1000	625	5	664	150
1.8	120	4.0	40	0.8	400	335	50	1000	625	5	664	150
1.8	120	4.0	40	0.8	400	335	50	900	575	5	664	150
1.8	120	4.0	40	0.8	400	335	50	900	575	5	664	150

See General Notes and Electrical Specification Notes on page 4-4.

Electrical Specifications

General Notes

- All measurements are made at 60Hz with a resistive load at an ambient temperature of +25˚C unless specified otherwise.
- Operating temperature range (T_J) is -40˚C to +125˚C except 0˚C to +125˚C for FastPaks.
- Storage temperature range (T_S) is -40˚C to +125˚C except -20˚C to +125˚C for FastPaks.
- Lead solder temperature is a maximum of 230˚C for 10 seconds maximum ≥ 1/16" (1.59mm) from case.
- The case temperature (T_C) is measured as shown on the dimensional outline drawings. See "Package Dimensions" section of this catalog.

Electrical Specification Notes

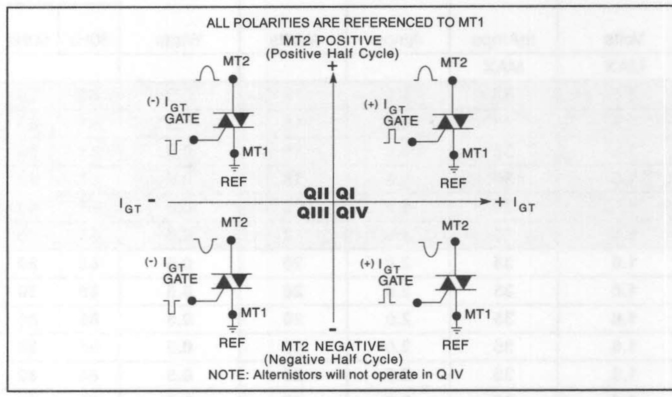
(1) For either polarity of MT2 with reference to MT1 terminal.
(2) For either polarity of gate voltage (V_{GT}) with reference to MT1 terminal.
(3) See Definition of Quadrants.
(4) See Figures 4.1 through 4.4 for current rating at specific operating temperature.
(5) See Figures 4.5 and 4.6 for i_T and v_T.
(6) See Figure 4.7 for V_{GT} vs T_C.
(7) See Figure 4.8 for I_{GT} vs T_C.
(8) See Figure 4.9 for I_H vs T_C.
(9) See Figures 4.10 and 4.11 for surge rating with specific durations.
(10) See Figure 4.12 for t_{gt} vs I_{GT}.
(11) See package outlines for lead form configurations. When ordering special lead forming, add type number as suffix to part number.
(12) Initial on-state current = 400 mA(DC) for 15-40A devices and 100mA for 6-12 Amp devices.
(13) See Figures 4.1 through 4.4 for maximum allowable case temperature at maximum rated current.
(14) Pulse width ≤ 10µs.
(15) For 6-12 Amp devices, $R_L = 60\Omega$; 15 Amp and above, $R_L = 30\Omega$
(16) 40 Amp pin terminal leads on K package can run 100˚C to 125˚C.
(17) Alternistor does not turn on in Quadrant IV.
(18) $T_c = T_J$ for test conditions in off-state
(19) I_{GT} = 200 mA for 6-12 Amp devices and 500 mA for 15-40 Amp devices with gate pulse having rise time of ≤ 0.1 microsecond.

Gate Characteristics

Teccor triacs may be turned on in the following ways:

- With in-phase signals (using standard AC line) Quadrants I and III are used.
- By applying unipolar pulses (gate always negative)—with negative gate pulses Quadrants II and III are used.

In all cases, if maximum surge capability is required, gate pulses should be a minimum of one magnitude above minimum I_{GT} rating with a steep rising waveform (≤1µs rise time).



Definition of Quadrants

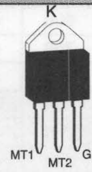
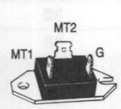
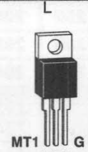
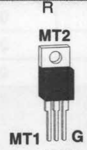
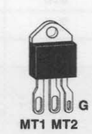
Electrical Isolation

Teccor's isolated Alternistor packages will withstand a minimum high potential test of 2500 VAC (RMS) from leads to mounting tab, over the operating temperature range of the device. See isolation table below for standard and optional isolation ratings.

ELECTRICAL ISOLATION FROM LEADS TO MOUNTING TAB**				
VAC (RMS)	Isolated TO-218AC	Isolated FASTPAK	Isolated TO-220AB	Isolated TO-218X
2500	Standard	Standard	Standard	Standard
4000	N/A	N/A	Optional *	N/A

* For 4000V isolation, use V suffix in part number.
** UL Recognized File E71639

THERMAL RESISTANCE (Steady State)
$R_{\theta JC}$ °C/W(TYP)

Type	K  Isolated** TO-218AC	P  FastPak** TO-3BASE	L  Isolated** THERMOTAB TO-220AB	R  Non-Isolated TO-220AB	J  Isolated** TO-218X
6 amps			3.3 [50]	2.1 [45]	
8 amps			2.8	1.8	
10 amps			2.6	1.5	
12 amps			2.3	1.4	
15 amps			2.1	1.3	
25 amps	1.35	1.3	2.0	1.1	1.32
40 amps	0.97	0.9			0.95

** UL Recognized Product per UL File E71639.

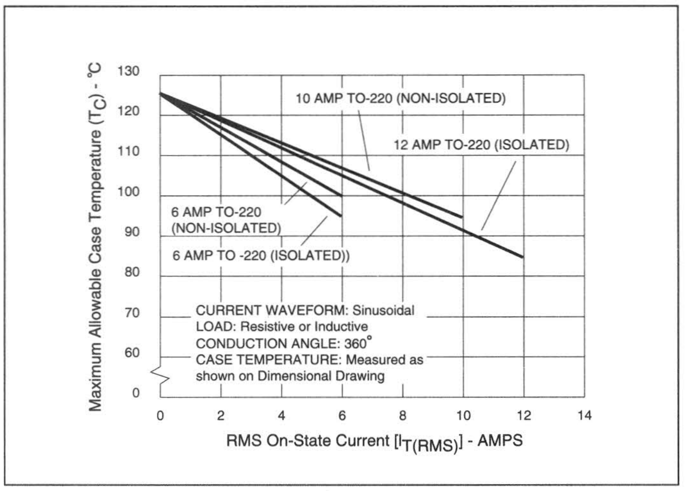


Figure 4.1 Maximum Allowable Case Temperature vs On-State Current (6-12 Amp Devices)

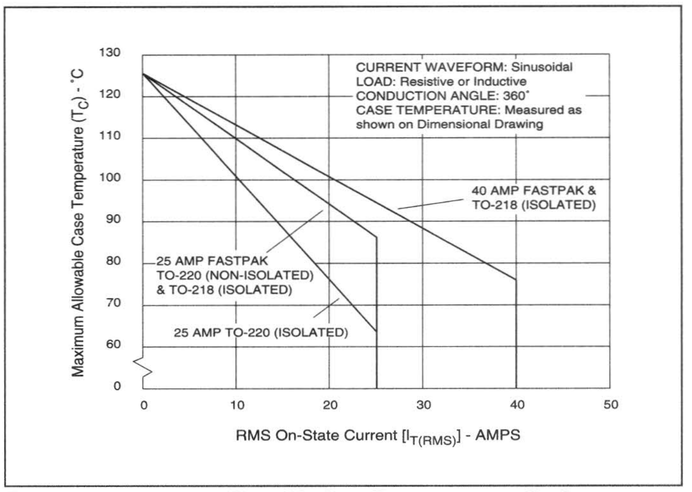


Figure 4.4 Maximum Allowable Case Temperature vs On-State Current (25 and 40 Amp Devices)

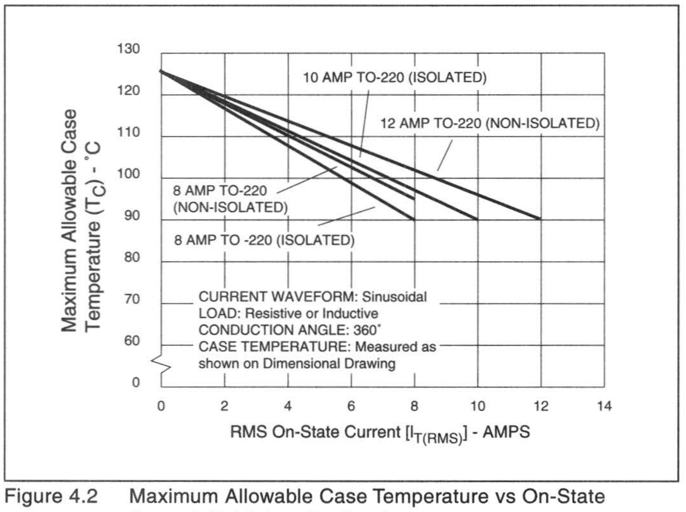


Figure 4.2 Maximum Allowable Case Temperature vs On-State Current (8-12 Amp Devices)

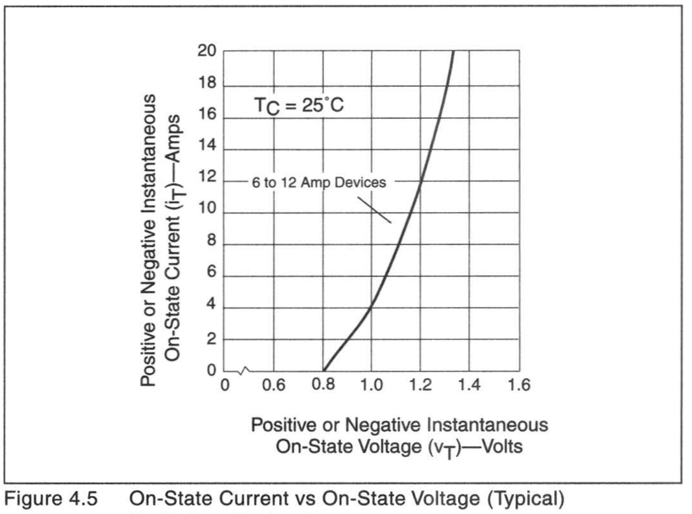


Figure 4.5 On-State Current vs On-State Voltage (Typical) (6-12 Amp Devices)

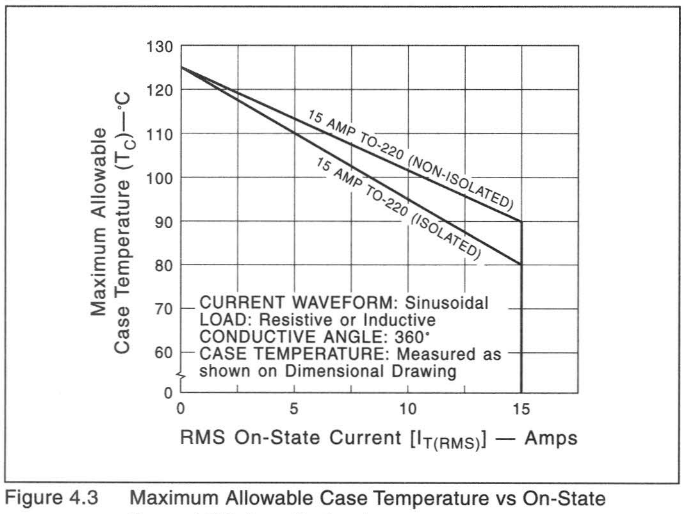


Figure 4.3 Maximum Allowable Case Temperature vs On-State Current (15 Amp Devices)

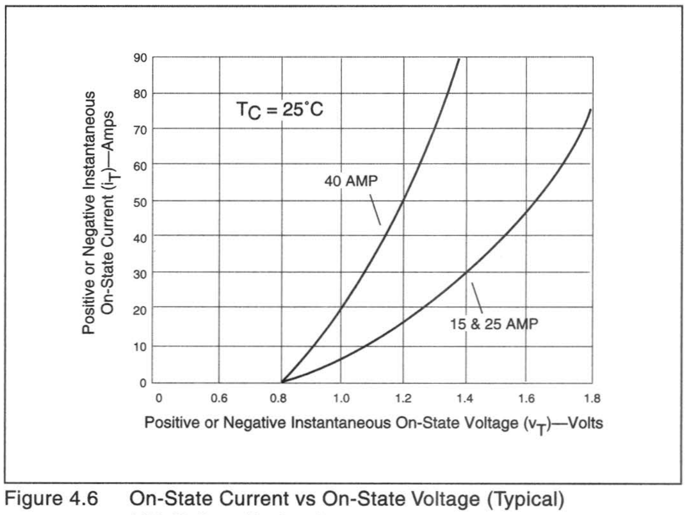


Figure 4.6 On-State Current vs On-State Voltage (Typical) (15-40 Amp Devices)

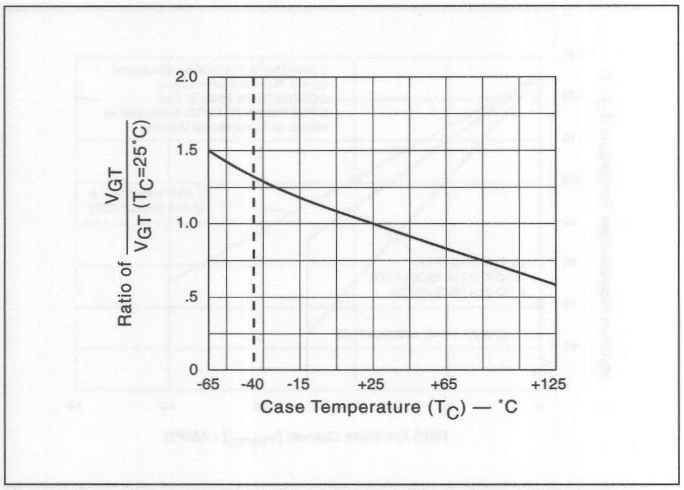


Figure 4.7 Normalized DC Gate Trigger Voltage for all Quadrants vs Case Temperature

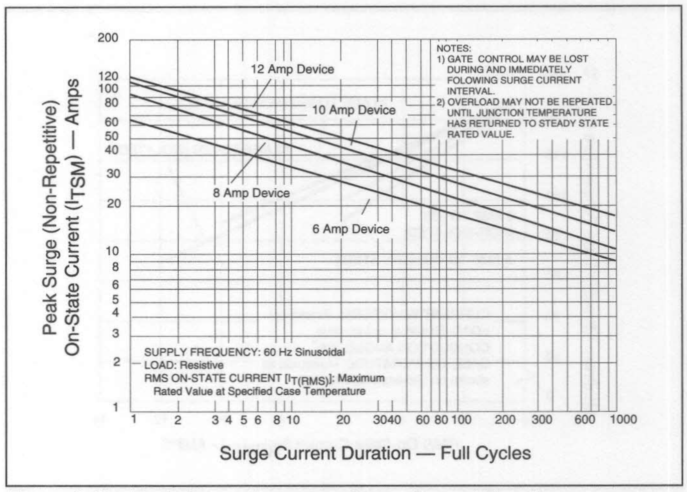


Figure 4.10 Peak Surge Current vs Surge Current Duration (6-12 Amp Devices)

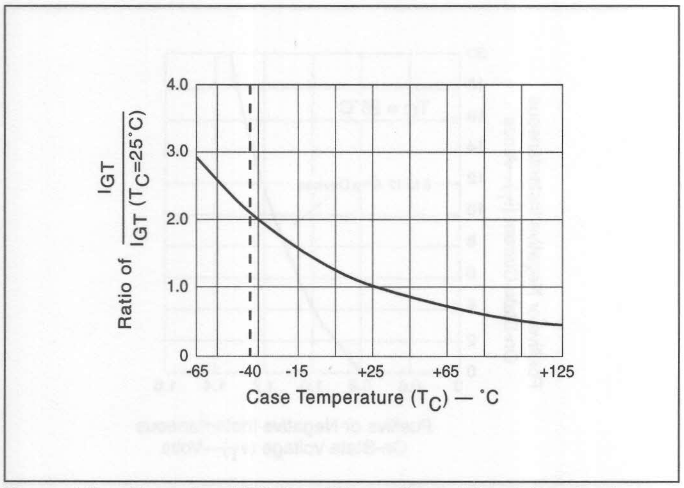


Figure 4.8 Normalized DC Gate Trigger Current for all Quadrants vs Case Temperature

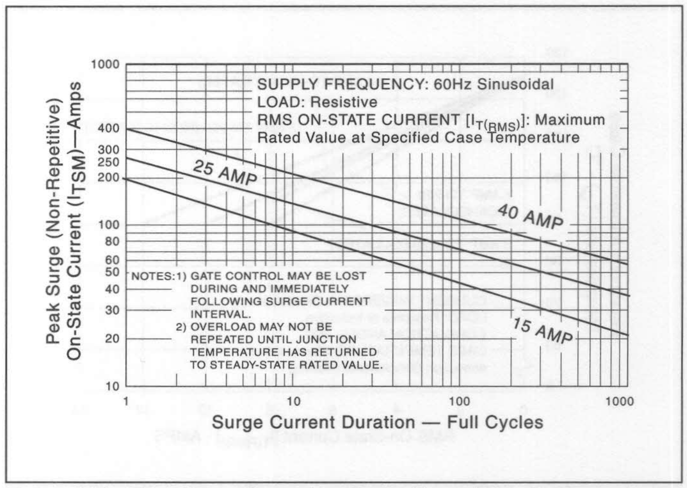


Figure 4.11 Peak Surge Current vs Surge Current Duration (15-40 Amp Devices)

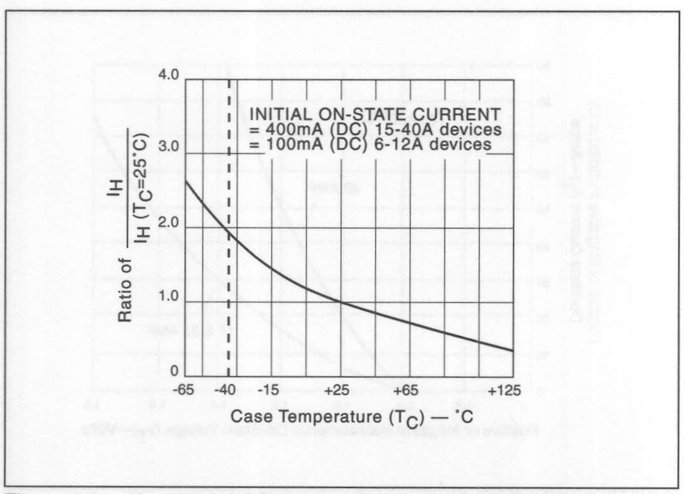


Figure 4.9 Normalized DC Holding Current vs Case Temperature

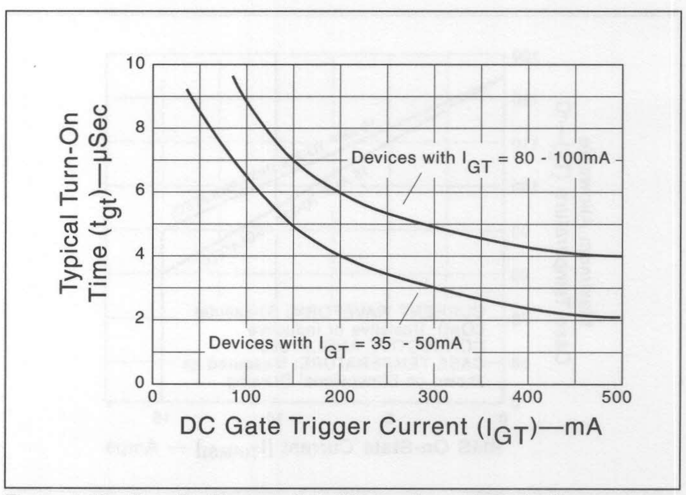


Figure 4.12 Turn-On Time vs Gate Trigger Current (Typical)

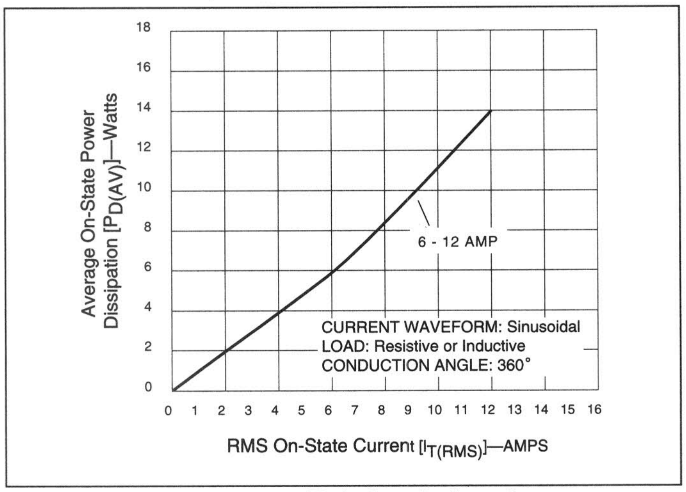


Figure 4.13 Power Dissipation (Typical) vs On-State Current (6-12 Amp Devices)

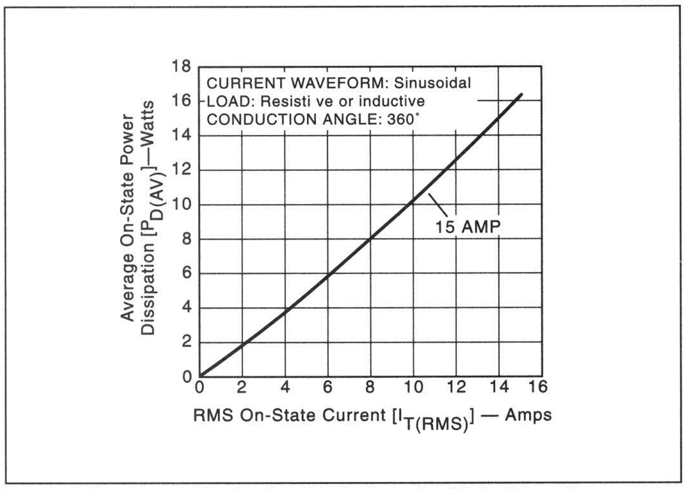


Figure 4.14 Power Dissipation (Typical) vs On-State Current (15 Amp Devices)

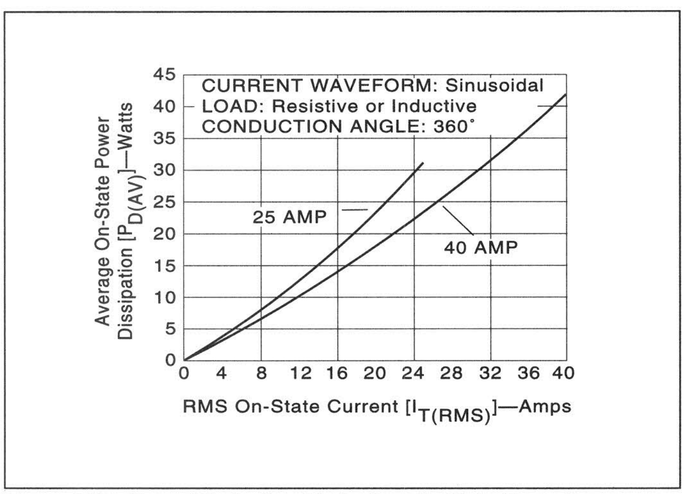
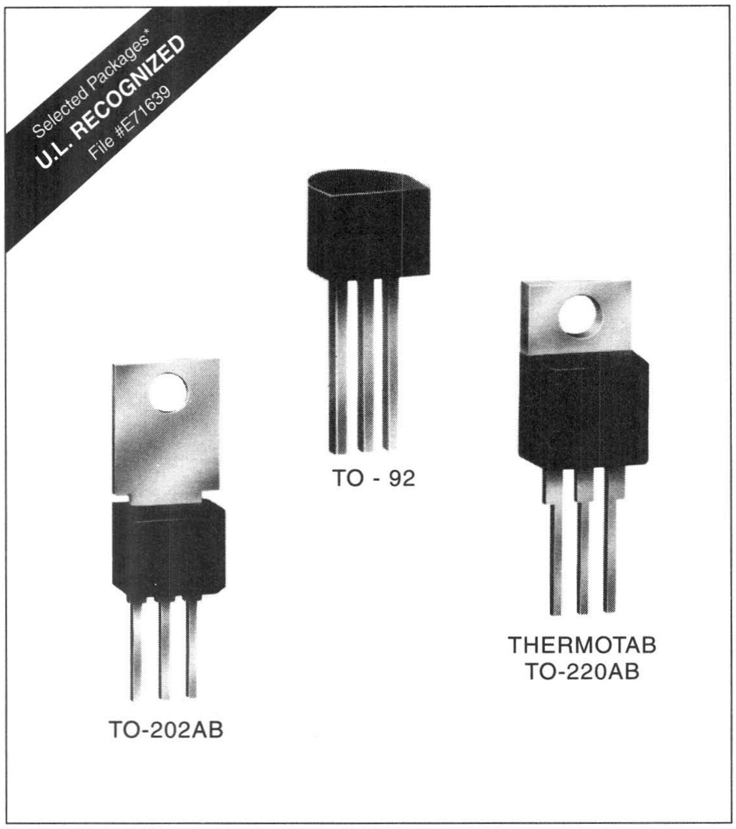
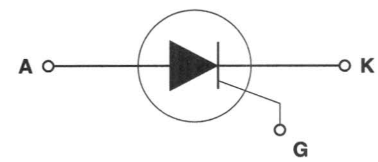


Figure 4.15 Power Dissipation (Typical) vs On-State Current (25 and 40 Amp Devices)

Notes





Sensitive SCRs

(0.8 – 10 Amps)

General Description

The Teccor Electronics, Inc. line of sensitive SCR semiconductors are half-wave unidirectional gate-controlled rectifiers (SCR-thyristor) which complement Teccor's line of power SCRs. This group of packages offers ratings of 0.8-10 amps, and 50-600 volts with gate sensitivities of 12-500 microamps. If gate currents in the 10-50 milliamp ranges are required, please consult Teccor's non-sensitive SCR technical data sheets.

Electrically Isolated Packages

This group of Teccor sensitive SCRs is available in a choice of three different product packages. The TO-220AB and TO-92 are electrically isolated where the case or tab is internally isolated to allow the use of low cost assembly and convenient packaging techniques.

Glass Passivation

Teccor's line of SCRs features glass-passivated junctions to ensure long term device reliability and parameter stability. Teccor's glass offers a rugged, reliable barrier against junction contamination.

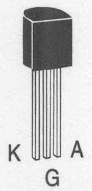
Tape-and-reel packaging is available for the TO-92 package. Please consult factory for more information.

Variations of devices covered in this data sheet are available for custom design applications. Please consult the factory for more information.

Features

- **Electrically-isolated To-220AB package**
- **High Voltage Capability up to 600 Volts**
- **High Surge Capability — up to 100 Amps**
- **Glass Chip Passivation**

Electrical Specifications

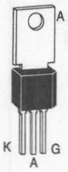
TYPE	Part Number	I_T		V_{DRM} & V_{RRM}	I_{GT}	I_{DRM} & I_{RRM}			V_{TM}	V_{GT}			I_H
	 TO-92	Maximum On-state Current (1) Amps		Repetitive Peak Off-state Forward & Reverse Voltage	DC Gate Trigger Current (2) (11) (17)	Peak Off-state Current at V_{DRM} & V_{RRM} (19) µAmps			Peak On-state Voltage T_C = 25˚C (3) (10)	DC Gate Trigger Voltage (4) (11) Volts			DC Holding Current Initial On-state Current =20mAmps (5) (14) (18)
	See "Package Dimensions" section for variations.	RMS	AV	Volts	µAmps	T_C = 25˚C	T_C= 100˚C	T_C = 125˚C	Volts	T_C = - 65˚C	T_C = 25˚C	T_C = 100˚C	mAmps
		MAX		MIN	MAX	MAX			MAX	MAX		MIN	MAX
0.8 Amp	EC103A	0.8	0.51	100	200	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103B	0.8	0.51	200	200	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103C	0.8	0.51	300	200	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103D	0.8	0.51	400	200	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103E	0.8	0.51	500	200	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103M	0.8	0.51	600	200	2.0	100		1.7	1.2	0.8	.25	5.0
	EC103A1	0.8	0.51	100	12	1.0	50		1.7	1.2	0.8	0.2	5.0
	EC103B1	0.8	0.51	200	12	1.0	50		1.7	1.2	0.8	0.2	5.0
	EC103C1	0.8	0.51	300	12	1.0	50		1.7	1.2	0.8	0.2	5.0
	EC103D1	0.8	0.51	400	12	1.0	50		1.7	1.2	0.8	0.2	5.0
	EC103E1	0.8	0.51	500	12	1.0	50		1.7	1.2	0.8	0.2	5.0
	EC103M1	0.8	0.51	600	12	2.0	100		1.7	1.2	0.8	0.2	5.0
	EC103A2	0.8	0.51	100	50	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103B2	0.8	0.51	200	50	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103C2	0.8	0.51	300	50	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103D2	0.8	0.51	400	50	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103E2	0.8	0.51	500	50	1.0	50		1.7	1.2	0.8	.25	5.0
	EC103M2	0.8	0.51	600	50	2.0	100		1.7	1.2	0.8	.25	5.0
	EC103A3	0.8	0.51	100	500	1.0	50		1.7	1.2	0.8	.25	8.0
	EC103B3	0.8	0.51	200	500	1.0	50		1.7	1.2	0.8	.25	8.0
	EC103C3	0.8	0.51	300	500	1.0	50		1.7	1.2	0.8	.25	8.0
	EC103D3	0.8	0.51	400	500	1.0	50		1.7	1.2	0.8	.25	8.0
	EC103E3	0.8	0.51	500	500	1.0	50		1.7	1.2	0.8	.25	8.0
	EC103M3	0.8	0.51	600	500	2.0	100		1.7	1.2	0.8	.25	8.0
	EC113A	0.8	0.51	100	200	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113B	0.8	0.51	200	200	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113C	0.8	0.51	300	200	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113D	0.8	0.51	400	200	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113E	0.8	0.51	500	200	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113M	0.8	0.51	600	200	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113A3	0.8	0.51	100	500	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113B3	0.8	0.51	200	500	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113C3	0.8	0.51	300	500	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113D3	0.8	0.51	400	500	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113E3	0.8	0.51	500	500	2.0	100		1.7	1.2	0.8	.25	15.0
	EC113M3	0.8	0.51	600	500	2.0	100		1.7	1.2	0.8	.25	15.0
	2N5060	0.8	0.51	30	200	1.0		50	1.7	1.2	0.8	.25	5.0
	2N5061	0.8	0.51	60	200	1.0		50	1.7	1.2	0.8	.25	5.0
	2N5062	0.8	0.51	100	200	1.0		50	1.7	1.2	0.8	.25	5.0
	2N5063	0.8	0.51	150	200	1.0		50	1.7	1.2	0.8	.25	5.0
	2N5064	0.8	0.51	200	200	1.0		50	1.7	1.2	0.8	.25	5.0
	2N6564	0.8	0.51	300	200	1.0		100	1.7	1.2	0.8	.25	5.0
	2N6565	0.8	0.51	400	200	1.0		100	1.7	1.2	0.8	.25	5.0
1.5 AMPS	TCR22-2	1.5	.95	50	200	1.0	50	100	1.5	1.0	0.8	.25	5.0
	TCR22-3	1.5	.95	100	200	1.0	50	100	1.5	1.0	0.8	.25	5.0
	TCR22-4	1.5	.95	200	200	1.0	50	100	1.5	1.0	0.8	.25	5.0
	TCR22-6	1.5	.95	400	200	1.0	50	100	1.5	1.0	0.8	.25	5.0
	TCR22-8	1.5	.95	600	200	2.0	100	200	1.5	1.0	0.8	.25	5.0

See General Notes and Electrical Specifications Notes on page 5-4.

I_{GM}	V_{GRM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt	di/dt	t_{gt}	t_q	I^2t
Peak Gate Current (16)	Peak Reverse Gate Voltage	Peak Gate Power Dissipation (16)	Average Gate Power Dissipation	Peak One Cycle Surge Forward Current (6) (7) (12)		Critical Rate-Of-Rise Of Forward Off-State Voltage	Maximum Rate-Of-Change Of On-State Current I_{GT} = 50mA With 0.1µs Rise Time	Gate Controlled Turn-On Time Gate Pulse = 10mA Min. Width = 15µs With Rise Time ≤ 0.1 µs (8)	Circuit Commutated Turn-Off Time (9)	RMS Surge (Non-Repetitive) On-State Current For A Period Of 8.3ms For Fusing
				Amps						
Amps	Volts	Watts	Watts	60Hz	50Hz	Volts/µSec	Amps/µSec	µSec	µSec	Amps^2/Sec
	MIN					MIN		TYP	MAX	
1.0	5.0	1.0	0.1	20	16	30	50	3.5	50	1.6
1.0	5.0	1.0	0.1	20	16	30	50	3.5	50	1.6
1.0	5.0	1.0	0.1	20	16	30	50	3.5	50	1.6
1.0	5.0	1.0	0.1	20	16	30	50	3.5	50	1.6
1.0	5.0	1.0	0.1	20	16	20	50	3.5	50	1.6
1.0	5.0	1.0	0.1	20	16	15	50	3.5	50	1.6
1.0	5.0	1.0	0.1	20	16	20	50	2.0	60	1.6
1.0	5.0	1.0	0.1	20	16	20	50	2.0	60	1.6
1.0	5.0	1.0	0.1	20	16	20	50	2.0	60	1.6
1.0	5.0	1.0	0.1	20	16	20	50	2.0	60	1.6
1.0	5.0	1.0	0.1	20	16	15	50	2.0	60	1.6
1.0	5.0	1.0	0.1	20	16	10	50	2.0	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	3.0	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	3.0	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	3.0	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	3.0	60	1.6
1.0	5.0	1.0	0.1	20	16	20	50	3.0	60	1.6
1.0	5.0	1.0	0.1	20	16	10	50	3.0	60	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	45	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	45	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	45	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	45	1.6
1.0	5.0	1.0	0.1	20	16	30	50	5.0	45	1.6
1.0	5.0	1.0	0.1	20	16	20	50	5.0	45	1.6
1.0	5.0	1.0	0.1	20	16	30	50	4.0	30	1.6
1.0	5.0	1.0	0.1	20	16	30	50	4.0	30	1.6
1.0	5.0	1.0	0.1	20	16	30	50	4.0	30	1.6
1.0	5.0	1.0	0.1	20	16	30	50	4.0	30	1.6
1.0	5.0	1.0	0.1	20	16	20	50	4.0	30	1.6
1.0	5.0	1.0	0.1	20	16	15	50	4.0	30	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	18	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	18	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	18	1.6
1.0	5.0	1.0	0.1	20	16	40	50	5.0	18	1.6
1.0	5.0	1.0	0.1	20	16	30	50	5.0	18	1.6
1.0	5.0	1.0	0.1	20	16	20	50	5.0	18	1.6
1.0	5.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	5.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	6.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	6.0	1.0	0.1	20	16	25	50	2.2	60	1.6
1.0	6.0	1.0	0.1	20	16	75	50	3.5	50	1.6
1.0	6.0	1.0	0.1	20	16	75	50	3.5	50	1.6
1.0	6.0	1.0	0.1	20	16	60	50	3.5	50	1.6
1.0	6.0	1.0	0.1	20	16	40	50	3.5	50	1.6
1.0	6.0	1.0	0.1	20	16	30	50	3.5	50	1.6

See General Notes and Electrical Specifications Notes on page 5-4.

Electrical Specifications

TYPE	Part Number Non-Isolated	I_T		V_{DRM} & V_{RRM}	I_{GT}	I_{DRM} & I_{RRM}		V_{TM}	V_{GT}			I_H	I_{GM}
		Maximum On-State Current (1)		Repetitive Peak Off-State Forward & Reverse Voltage	DC Gate Trigger Current (2) (11) (13)	Peak Off-State Current at V_{DRM} & V_{RRM} (19)		Peak On-State Voltage $T_C = 25^{\circ}C$ (3) (10)	DC Gate Trigger Voltage (4) (11)			DC Holding Current Initial On-State Current = 20mA (5) (15) (18)	Peak Gate Current (16)
	TO-202AB	Amps				µAmps			Volts			mAmps	
	See "Package Dimensions" section for variations.	$I_{T(RMS)}$	$I_{T(AV)}$	Volts	µAmps	$T_C =$ 25˚C	$T_C =$ 110˚C	Volts	$T_C =$ - 40˚C	$T_C =$ 25˚C	$T_C =$ 110˚C	$T_C = 25^{\circ}C$	Amps
		MAX	MAX	MIN	MAX	MAX	MAX	MAX	MAX	MAX	MIN	MAX	
4.0 Amps	T106F1	4.0	2.5	50	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T106A1	4.0	2.5	100	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T106B1	4.0	2.5	200	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T106C1	4.0	2.5	300	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T106D1	4.0	2.5	400	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T106E1	4.0	2.5	500	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T106M1	4.0	2.5	600	200	2.0	100	2.2	1.0	0.8	0.2	5.0	1.0
	T107F1	4.0	2.5	50	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0
	T107A1	4.0	2.5	100	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0
	T107B1	4.0	2.5	200	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0
	T107C1	4.0	2.5	300	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0
	T107D1	4.0	2.5	400	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0
	T107E1	4.0	2.5	500	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0
	T107M1	4.0	2.5	600	500	2.0	100	2.5	1.0	0.8	0.2	6.0	1.0

General Notes

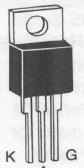
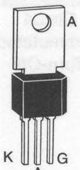
- Teccor 2N5060 and 2N6564 Series devices conform to all JEDEC registered data. See specifications table on page 5-2.
- The case temperature (TC) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.
- All measurements (except I_{GT}) are made with an external resistor $R_{GK} = 1k\Omega$ unless otherwise noted.
- All measurements are made at 60Hz with a resistive load at an ambient temperature of $+25^{o}C$ unless otherwise specified.
- Operating temperature (T_J) is $-65^{o}C$ to $+110^{o}C$ for "EC" Series devices; $-65^{o}C$ to $+125^{o}C$ for "2N" Series devices; $-40^{o}C$ to $+125^{o}C$ for "TCR" Series; and $-40^{o}C$ to $+110^{o}C$ for all others.
- Storage temperature range (T_S) is $-65^{o}C$ to $+150^{o}C$ for TO-92 devices; $-40^{o}C$ to $+150^{o}C$ for TO-202 devices; and $-40^{o}C$ to $+125^{o}C$ for all others.
- Lead solder temperature is a maximum of $+230^{o}C$ for 10 seconds maximum ≥ 1/16" (1.59mm) from case.

Electrical Specification Notes

(1) See Figures 5.1 through 5.9 for current ratings at specified operating case temperatures.
(2) See Figure 5.10 for I_{GT} vs T_C.
(3) See Figure 5.11 for instantaneous on-state current (i_T) vs on-state voltage (v_T) - (typical).
(4) See Figure 5.12 for V_{GT} vs T_C.
(5) See Figure 5.13 for I_H vs T_C.
(6) For more than one full cycle, see Figure 5.14.
(7) 0.8 - 4.0A devices also have a pulse peak forward current on-state rating (repetitive) of 75A. This rating applies for operation at 60Hz, 75˚C maximum tab (or anode) lead temperature, switching from 80V peak, sinusoidal current pulse width of 10µs minimum, 15µs maximum. See Figures 5.20 and 5.21.
(8) See Figure 5.15 for t_{gt} vs I_{GT}.
(9) Test conditions as follows: $T_C \leq 80^{\circ}C$, rectangular current waveform; rate-of-rise of current ≤ 10A/µs. Rate-of-reversal of current ≤ 5A/µs. I_{TM} = 1A (50µs pulse) Repetition Rate = 60pps. V_{RRM} = Rated. V_R = 15V minimum, V_{DRM} = Rated. Rate-of-rise reapplied forward blocking voltage = 5V/µs. Gate Bias = 0V, 100Ω (during turn-off time interval).
(10) Test condition is maximum rated RMS current except TO-92 devices are $1.2A_{PK}$; T106/T107 devices are $4A_{PK}$.
(11) V_D = 6VDC, R_L = 100Ω. See Figure 5.19 for simple test circuit for measuring gate trigger voltage and gate trigger current.
(12) See Figures 5.1 through 5.9 for maximum allowable case temperature at maximum rated current.
(13) I_{GT} = 500µA maximum for $T_C = -40^{\circ}C$ for T106 devices.
(14) I_H = 10mA maximum for $T_C = -65^{\circ}C$ for 2N5060 Series and 2N6564 Series devices.
(15) I_H = 6mA maximum for $T_C = -40^{\circ}C$ for T106 devices.
(16) Pulse Width ≤ 10µs.
(17) I_{GT} = 350µA maximum at $T_C = -65^{\circ}C$ for 2N5060 Series and 2N6564 Series devices.
(18) Latching current can be higher than 20mA for higher I_{GT} types. Also latching current can be much higher at -40˚C. See Figure 5.18.
(19) $T_C = T_J$ for test conditions in off-state.

V_{GRM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt	di/dt	t_{gt}	t_q	I^2t
Peak Reverse Gate Voltage	Peak Gate Power Dissipation (16)	Average Gate Power Dissipation	Peak One Cycle Surge Forward Current (6) (7) (12) Amps		Critical Rate-Of-Rise Of Forward Off-State Voltage Volts/µSec	Maximum Rate-Of-Change Of On-State Current I_{GT} = 50mA with 0.1µs Rise Time	Gate Controlled Turn-On Time Gate Pulse = 10mA Min. Width = 15µs with Rise Time ≤ 0.1 µs (8)	Circuit Commutated Turn-Off Time (9)	RMS Surge (Non-Repetitive) On-State Current For A Period Of 8.3 msec for Fusing
					T_C = 110˚C				
Volts	Watts	Watts	60Hz	50Hz		Amps/µSec	µSec	µSec	$Amps^2Sec$
MIN					TYP		TYP	MAX	
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	4.0	50	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6
6.0	1.0	0.1	20	16	8	50	5.0	45	1.6

Electrical Specifications

TYPE	Part Number		I_T		V_{DRM} & V_{RRM}	I_{GT}	I_{DRM} & I_{RRM}		V_{TM}	V_{GT}			I_H
	Isolated	Non-Isolated											
	 K A G TO-220AB	 A K A G TO-202AB	Maximum On-State Current (1) Amps		Repetitive Peak Off-State Forward & Reverse Voltage	DC Gate Trigger Current (2) (11)	Peak Off-State Current at V_{DRM} & V_{RRM} (19) mAmps		Peak On-State Voltage $T_C = 25^\circ C$ (3) (10)	DC Gate Trigger Voltage (4) (11) Volts			DC Holding Current Initial On-State Current = 20mA (5) (17)
	See "Package Dimensions" section for variations.		$I_{T(RMS)}$	$I_{T(AV)}$	Volts	µAmps	$T_C = 25^\circ C$	$T_C = 110^\circ C$	Volts	$T_C = -40^\circ C$	$T_C = 25^\circ C$	$T_C = 110^\circ C$	mAmps
			MAX	MAX	MIN	MAX	MAX	MAX	MAX	MAX	MAX	MIN	MAX
6.0 Amps	S0506LS2	S0506FS21	6.0	3.8	50	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S0506LS3	S0506FS31	6.0	3.8	50	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S1006LS2	S1006FS21	6.0	3.8	100	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S1006LS3	S1006FS31	6.0	3.8	100	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S2006LS2	S2006FS21	6.0	3.8	200	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S2006LS3	S2006FS31	6.0	3.8	200	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S4006LS2	S4006FS21	6.0	3.8	400	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S4006LS3	S4006FS31	6.0	3.8	400	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S6006LS2	S6006FS21	6.0	3.8	600	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S6006LS3	S6006FS31	6.0	3.8	600	500	.005	0.25	1.6	1.0	0.8	.25	8.0
8.0 Amps	S0508LS2	S0508FS21	8.0	5.1	50	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S0508LS3	S0508FS31	8.0	5.1	50	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S1008LS2	S1008FS21	8.0	5.1	100	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S1008LS3	S1008FS31	8.0	5.1	100	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S2008LS2	S2008FS21	8.0	5.1	200	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S2008LS3	S2008FS31	8.0	5.1	200	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S4008LS2	S4008FS21	8.0	5.1	400	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S4008LS3	S4008FS31	8.0	5.1	400	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S6008LS2	S6008FS21	8.0	5.1	600	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S6008LS3	S6008FS31	8.0	5.1	600	500	.005	0.25	1.6	1.0	0.8	.25	8.0
10.0 Amps	S0510LS2	S0510FS21	10.0	6.4	50	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S0510LS3	S0510FS31	10.0	6.4	50	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S1010LS2	S1010FS21	10.0	6.4	100	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S1010LS3	S1010FS31	10.0	6.4	100	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S2010LS2	S2010FS21	10.0	6.4	200	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S2010LS3	S2010FS31	10.0	6.4	200	500	.005	0.25	1.6	1.0	0.8	.25	8.0
	S4010LS2	S4010FS21	10.0	6.4	400	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S4010LS3	S4010FS31	10.0	6.4	400	500	.005	0.25	1.6	1.0	0.8	.26	8.0
	S6010LS2	S6010FS21	10.0	6.4	600	200	.005	0.25	1.6	1.0	0.8	.25	6.0
	S6010LS3	S6010FS31	10.0	6.4	600	500	.005	0.25	1.6	1.0	0.8	.25	8.0

General Notes

- Teccor 2N5060 and 2N6564 Series devices conform to all JEDEC registered data. See specifications table on page 5-2.
- The case temperature (TC) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.
- All measurements (except I_{GT}) are made with an external resistor $R_{GK} = 1k\Omega$ unless otherwise noted.
- All measurements are made at 60Hz with a resistive load at an ambient temperature of +25°C unless otherwise specified.
- Operating temperature (T_J) is -65°C to + 110°C for "EC" Series devices; -65°C to +125°C for "2N" Series devices; -40°C to +125°C for "TCR" Series; and -40°C to +110°C for all others.
- Storage temperature range (T_S) is -65°C to + 150°C for TO-92 devices; -40°C to +150°C for TO-202 devices; and -40°C to +125°C for all others.
- Lead solder temperature is a maximum of +230°C for 10 seconds maximum ≥ 1/16" (1.59mm) from case.

I_{GM}	V_{GRM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt	di/dt	t_{gt}	t_q	I^2t
Peak Gate Current (16)	Peak Reverse Gate Voltage	Peak Gate Power Dissipation (16)	Average Gate Power Dissipation	Peak One Cycle Surge Forward Current (6) (12)		Critical Rate-Of-Rise Of Forward Off-State Voltage Volts/µSec	Maximum Rate-Of-Change Of On-State Current I_{GT} = 50mA With 0.1 µs Rise Time	Gate Controlled Turn-On Time Gate Pulse = 10mA Min. Width = 15µs With Rise Time ≤ 0.1 µs (8)	Circuit Commutated Turn-Off Time (9)	RMS Surge (Non-Repetitive) On-State Current For A Period Of 8.3 mSec For Fusing
Amps	Volts	Watts	Watts	Amps		T_C = 110˚C	Amps/ µSec	µSec	µSec	Amps^{2}Sec
	MIN			60 Hz	50 Hz	TYP		TYP	MAX	
1.0	6.0	1.0	0.1	100	83	20	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	20	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	10	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	10	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	10	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	10	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	5	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	5	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	5	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	5	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	20	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	20	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	10	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	10	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	10	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	10	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	5	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	5	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	5	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	5	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	20	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	20	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	10	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	10	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	10	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	10	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	5	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	5	100	5.0	45	41
1.0	6.0	1.0	0.1	100	83	5	100	4.0	50	41
1.0	6.0	1.0	0.1	100	83	5	100	5.0	45	41

Electrical Specification Notes

(1) See Figures 5.1 through 5.9 for current ratings at specified operating case temperatures.

(2) See Figure 5.10 for I_{GT} vs T_C.

(3) See Figure 5.11 for instantaneous on-state current (i_T) vs on-state voltage (v_T) - (typical).

(4) See Figure 5.12 for V_{GT} vs T_C.

(5) See Figure 5.13 for I_H vs T_C.

(6) For more than one full cycle, see Figure 5.14.

(7) 0.8 - 4.0A devices also have a pulse peak forward current on-state rating (repetitive) of 75A. This rating applies for operation at 60Hz, 75˚C maximum tab (or anode) lead temperature, switching from 80V peak, sinusoidal current pulse width of 10µs minimum, 15µs maximum. See Figures 5.20 and 5.21.

(8) See Figure 5.15 for t_{gt} vs I_{GT}.

(9) Test conditions as follows:
$T_C \le 80$˚C, rectangular current waveform; rate-of-rise of current ≤ 10A/µs. Rate-of-reversal of current ≤ 5A/µs. I_{TM} = 1A (50µs pulse) Repetition Rate = 60pps. V_{RRM} = Rated.
V_R = 15V minimum, V_{DRM} = Rated. Rate-of-rise reapplied forward blocking voltage= 5V/µs. Gate Bias = 0V, 100Ω (during turn-off time interval).

(10) Test condition is maximum rated RMS current except TO-92 devices are $1.2A_{PK}$; T106/T107 devices are $4A_{PK}$.

(11) V_D = 6VDC, R_L = 100Ω. See Figure 5.19 for simple test circuit for measuring gate trigger voltage and gate trigger current.

(12) See Figures 5.1 through 5.9 for maximum allowable case temperature at maximum rated current.

(13) I_{GT} = 500µA maximum for T_C = -40˚C for T106 devices.

(14) I_H = 10mA maximum for T_C = -65˚C for 2N5060 Series and 2N6564 Series devices.

(15) I_H = 6mA maximum for T_C = -40˚C for T106 devices.

(16) Pulse Width ≤ 10µs.

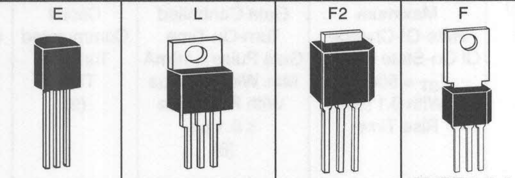
(17) I_{GT} = 350µA maximum at T_C = -65˚C for 2N5060 Series and 2N6564 Series devices.

(18) Latching current can be higher than 20mA for higher I_{GT} types. Also latching current can be much higher at -40˚C. See Figure 5.18.

(19) $T_C = T_J$ for test conditions in off-state.

Electrical Specifications

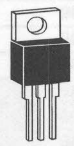
THERMAL RESISTANCE (STEADY STATE) $R_{\theta JC}$ [$R_{\theta JA}$] °C/W (TYPICAL)	E	L	F2	F
	TO-92	THERMOTAB TO-220AB	TYPE 2 TO-202AB	TYPE 1 & 3 TO-202AB
0.8 Amp	75 [160]			
1.5 Amps	50 [160]			
4.0 Amps			10 [100]	6.2 [80]
6.0 Amps		4.0		4.3
8.0 Amps		3.4		3.9
10.0 Amps		3.0		3.4



Electrical Isolation

Teccor's isolated sensitive SCRs will withstand a minimum high potential test of 2500 VAC RMS from leads to mounting tab over the device's operating temperature range. See table below for other standard and optional isolation ratings.

ELECTRICAL ISOLATION FROM LEADS TO MOUNTING TAB	
VAC(RMS)	THERMOTAB** TO-220AB
2500	**Standard**
4000	**Optional***



*For 4000V Isolation use "V" Suffix in part number
**UL Recognized File #E71639

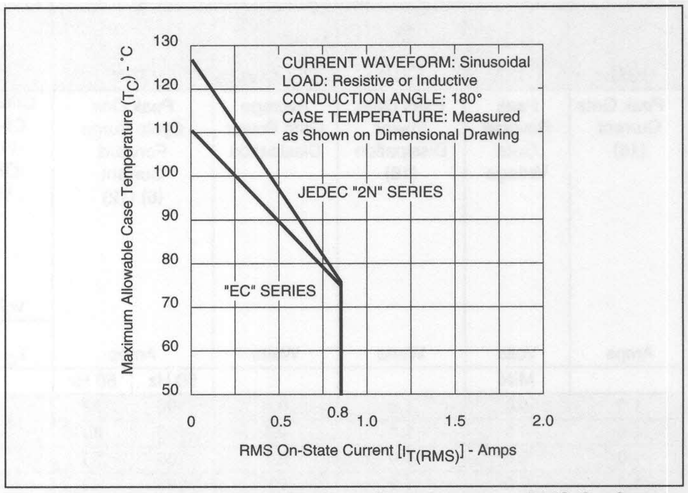


Figure 5.1 Maximum Allowable Case Temperature vs RMS On-State Current (JEDEC "2N" Series and "EC" Series)

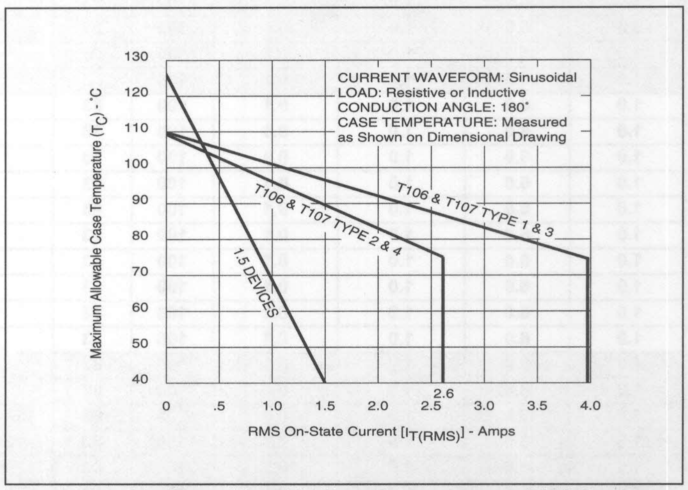


Figure 5.2 Maximum Allowable Case Temperature vs RMS On-State Current (T106 and T107)

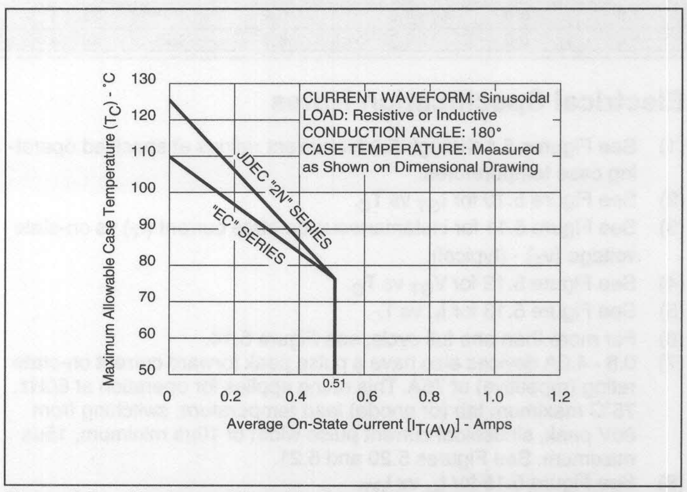


Figure 5.3 Maximum Allowable Case Temperature vs Average On-State Current (JEDEC "2N" Series and "EC" Series)

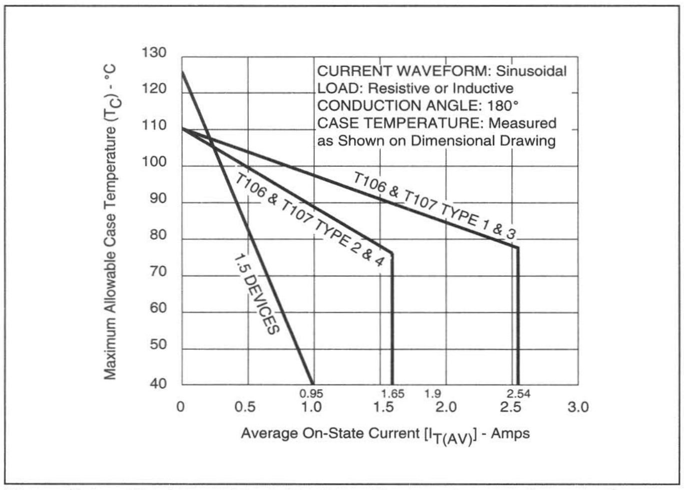


Figure 5.4 Maximum Allowable Case Temperature vs Average On-State Current (T106 and T107)

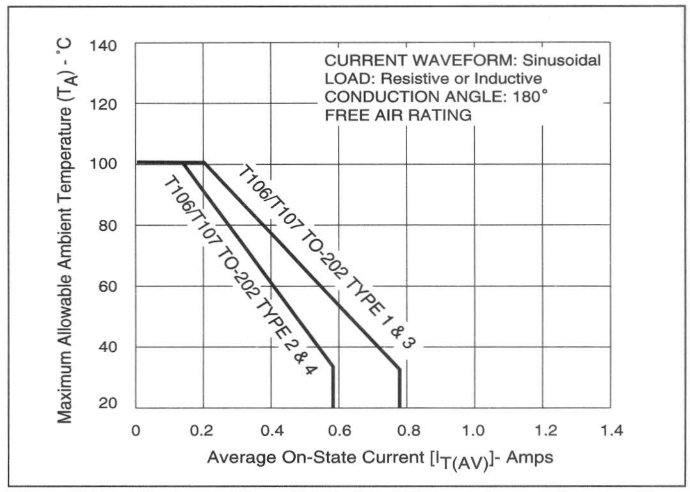


Figure 5.7 Maximum Allowable Ambient Temperature vs Average On-State Current

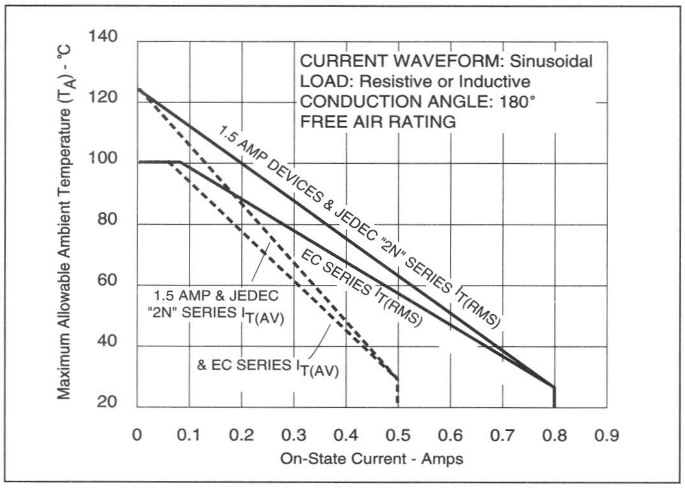


Figure 5.5 Maximum Allowable Ambient Temperature vs On-State Current (1.5 Amp, JEDEC "2N" Series and "EC" Series)

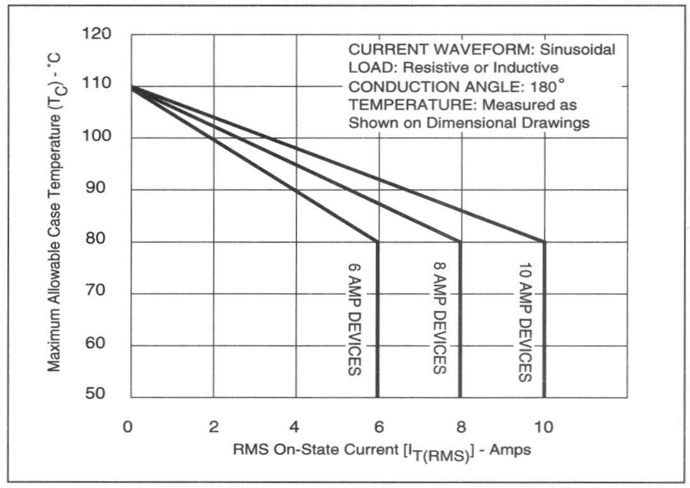


Figure 5.8 Maximum Allowable Case Temperature vs RMS On-State Current

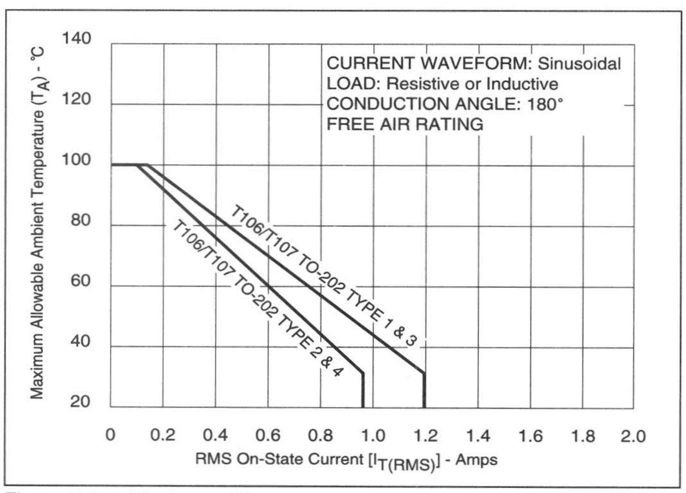


Figure 5.6 Maximum Allowable Ambient Temperature vs RMS On-State Current (T106 and T107)

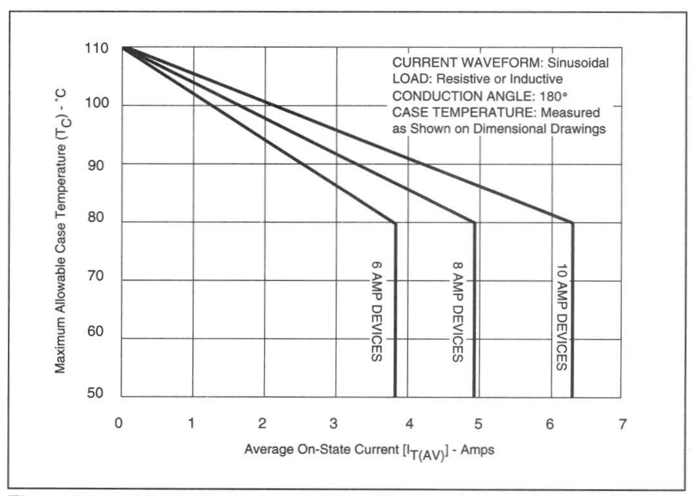


Figure 5.9 Maximum Allowable Case Temperature vs Average On-State Current

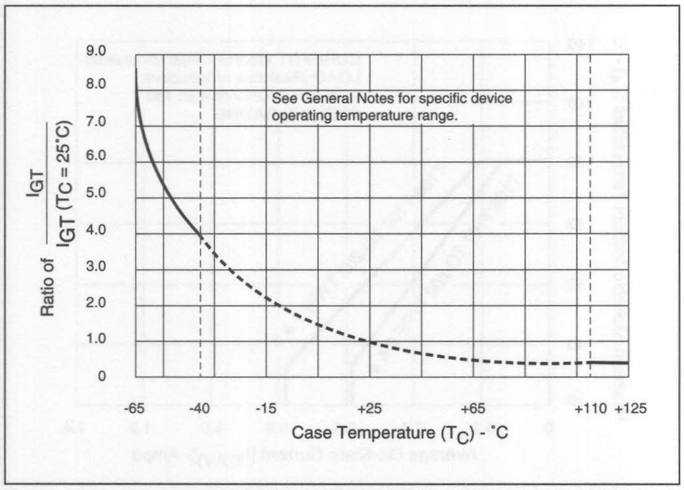


Figure 5.10 Normalized DC Gate-Trigger Current vs Case Temperature

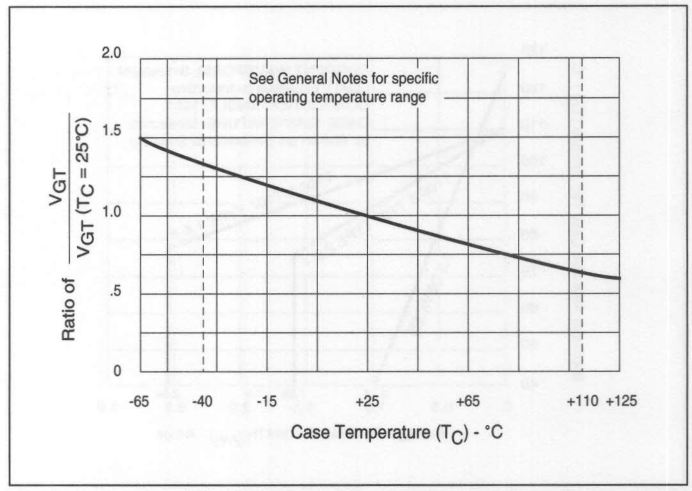


Figure 5.12 Normalized DC Gate-Trigger Voltage vs Case Temperature

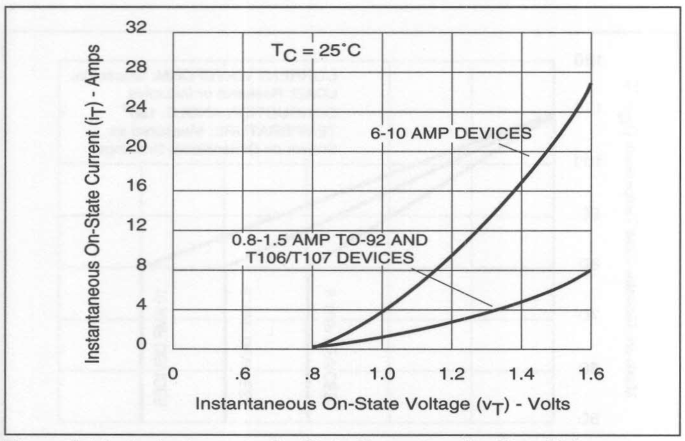


Figure 5.11 Instantaneous On-State Current vs On-State Voltage (Typical)

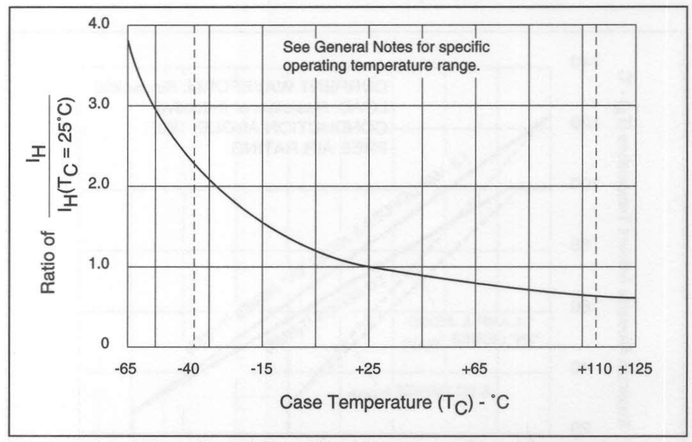


Figure 5.13 Normalized DC Holding Current vs Case Temperature

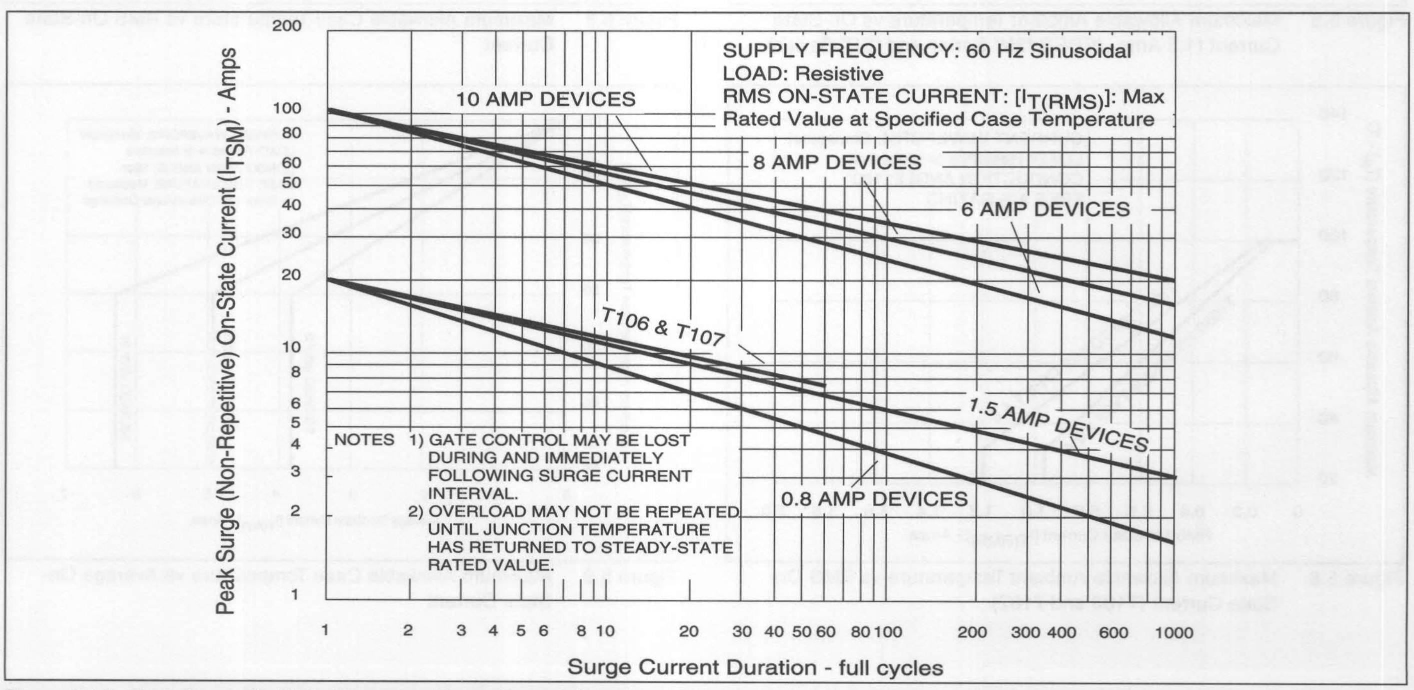


Figure 5.14 Peak Surge On-State Current vs Surge Current Duration

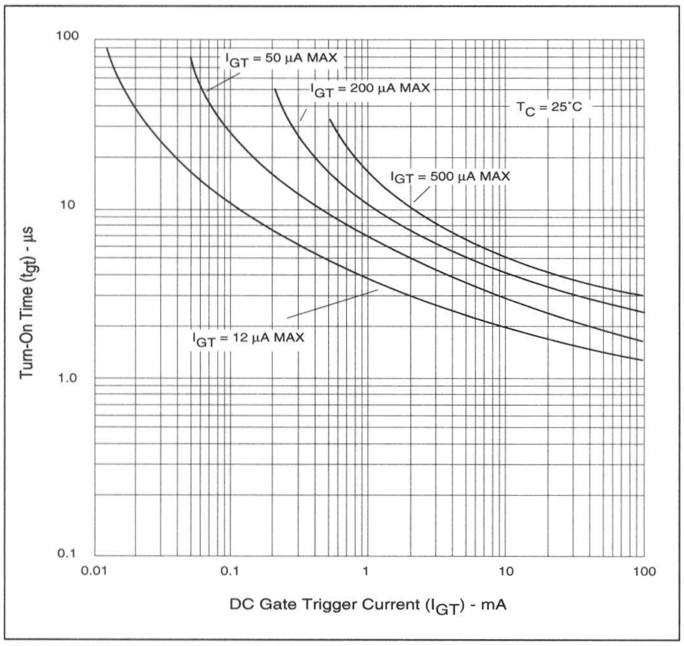


Figure 5.15 Typical Turn-On Time vs Gate Trigger Current

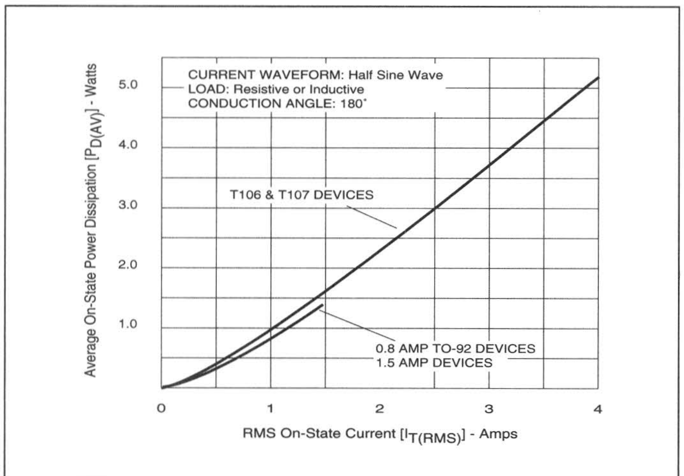


Figure 5.16 Power Dissipation (Typical) vs RMS On-State Current

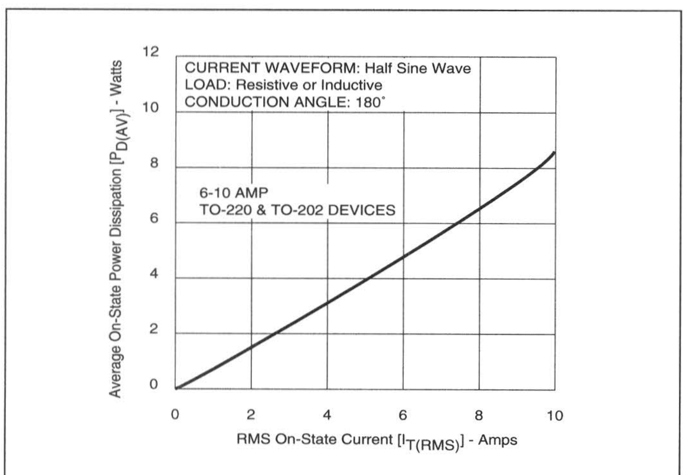


Figure 5.17 Power Dissipation (Typical) vs RMS On-State Current

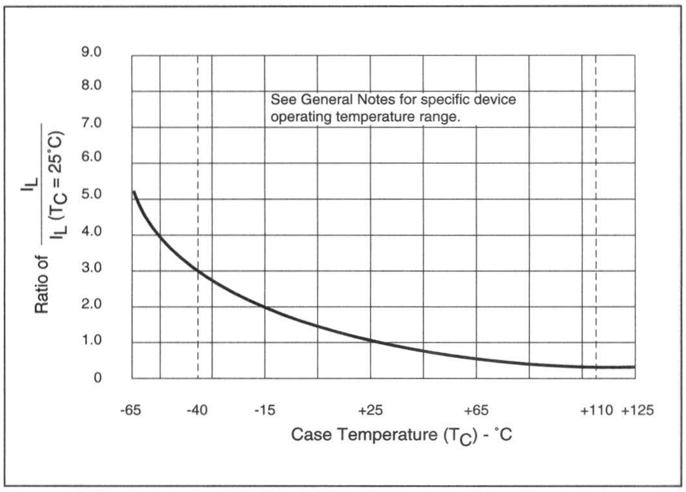


Figure 5.18 Normalized DC Latching Current vs Case Temperature

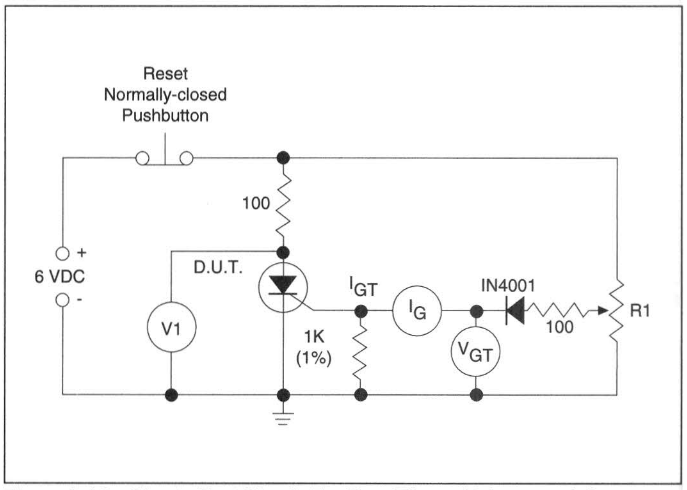


Figure 5.19 Simple Test Circuit For Gate Trigger Voltage and Current Measurement

Note: V1 — 0-10 volt DC meter
VGT — 0-1 volt DC meter
I_G — 0-1mA DC millimeter
R1 — 1K potentiometer

To measure gate trigger voltage and current, raise gate voltage (V_{GT}) until meter reading V1 drops from 6 volts to 1 volt. Gate trigger voltage is the reading on V_{GT} just prior to V1 dropping. Gate trigger current I_{GT} can be computed from the relationship:

$$I_{GT} = I_G - \frac{V_{GT}}{1000} Amps$$

where I_G is reading (in amps) on meter just prior to V1 dropping.

Note: I_{GT} may turn out to be a negative quantity (trigger current flows out from gate lead).

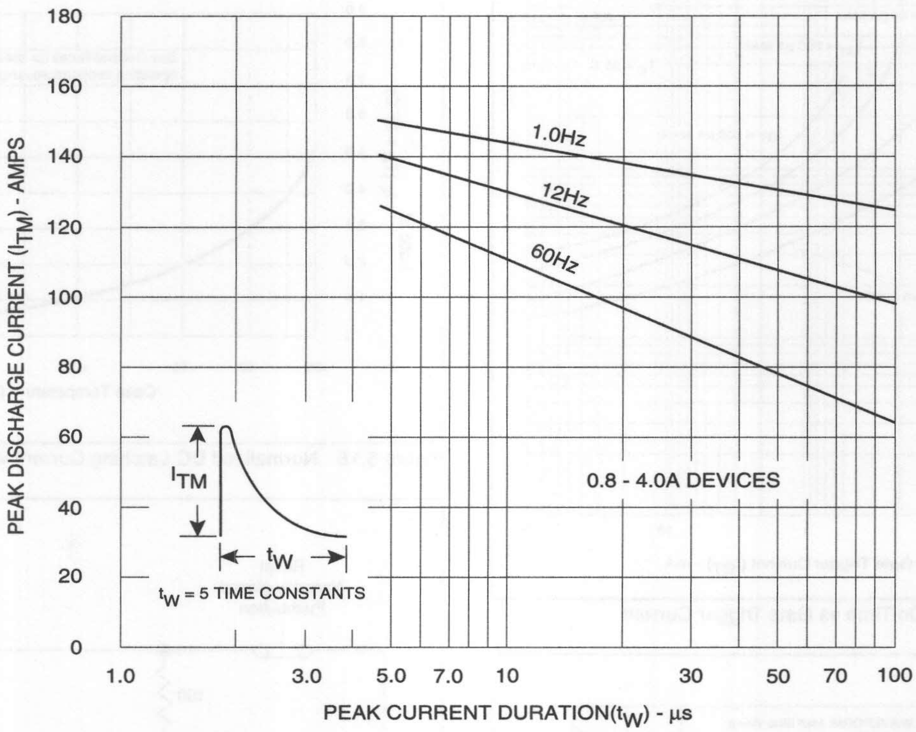


Figure 5.20 Peak Repetitive Capacitor Discharge Current

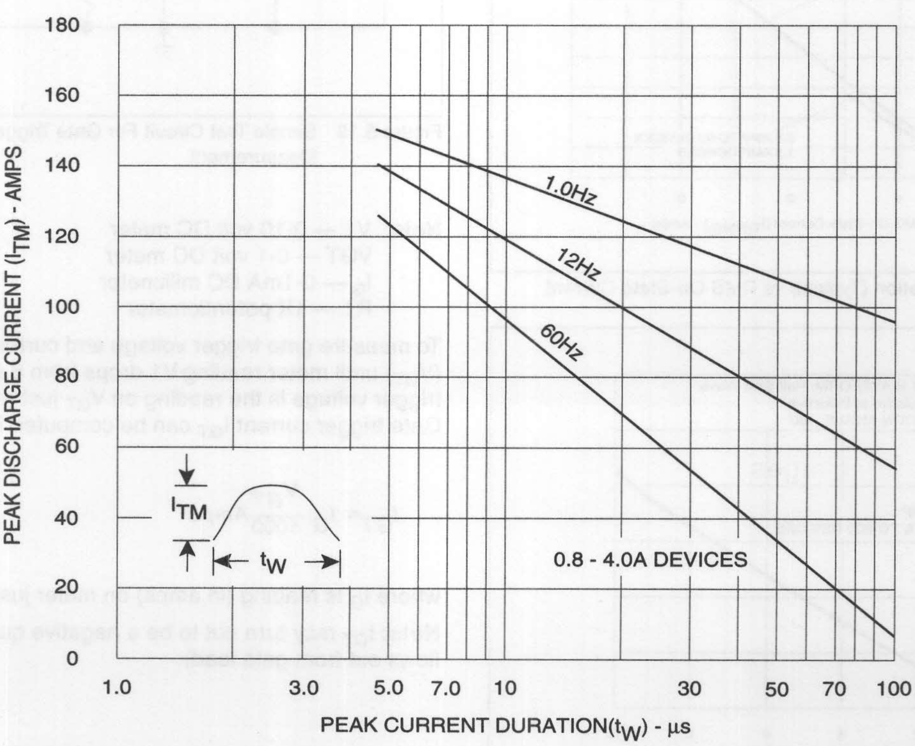
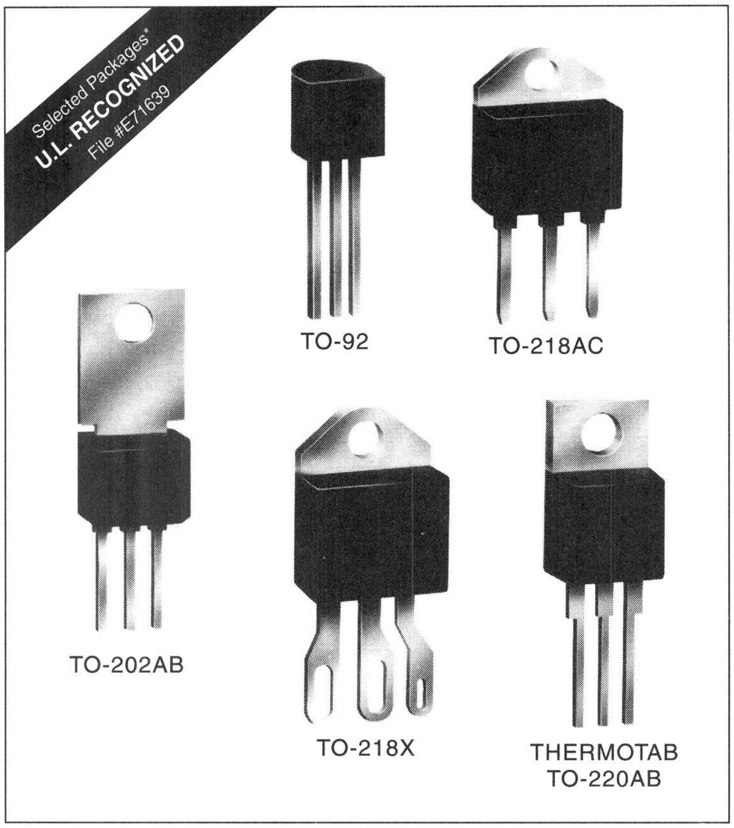
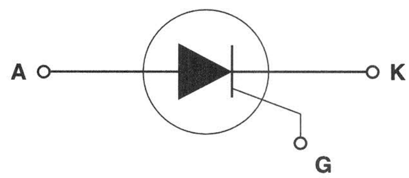


Figure 5.21 Peak Repetitive Sinusoidal Curve





SCRs

(1 – 70 Amps)

General Description

The Teccor Electronics line of thyristor SCR semi-conductors are half-wave, unidirectional, gate-controlled rectifiers which complement Teccor's line of sensitive SCRs. Teccor offers devices with ratings of 1-70 amps and 50-800 volts, with gate sensitivities from 10-50 milliamps. If gate currents in the 12-500 microamp ranges are required, please consult Teccor's sensitive SCR technical data sheets.

Electrically Isolated Packages

Teccor's SCRs are available in a choice of nine different device packages. Four (of the eight) packages are offered in electrically isolated construction where the case or tab is internally isolated to allow the use of low-cost assembly and convenient packaging techniques.

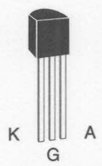
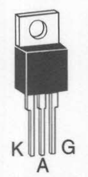
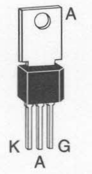
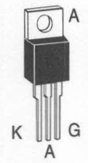
The Teccor line of SCRs features glass passivated device junctions to ensure long term device reliability and parameter stability. Teccor's glass offers a rugged, reliable barrier against junction contamination.

Variations of devices covered in this data sheet are available for custom design applications. Please consult the factory for more information.

Features

- **Electrically-isolated package**
- **High voltage capability — 50 up to 800 Volts**
- **High surge capability — up to 950 Amps**
- **Glass passivated chip**

Electrical Specifications

TYPE	Part Number: Isolated  TO - 92	Part Number: Isolated  TO - 220AB	Part Number: Non-Isolated  TO - 202AB	Part Number: Non-Isolated  TO -220AB	I_T Maximum On-State Current (1) (2) Amps $I_{T(RMS)}$	I_T IT(AV)	V_{DRM} & V_{RRM} Repetitive Peak Off-State Forward & Reverse Voltage	I_{GT} DC Gate Trigger Current V_D = 12VDC R_L = 60Ω (4)	I_{GT}	I_{DRM} & I_{RRM} Peak Off-State Forward & Reverse Current at V_{DRM} & V_{RRM} (13) mAmps T_C = 25˚C	I_{DRM} & I_{RRM} T_C = 100˚C	I_{DRM} & I_{RRM} T_C = 125˚C	V_{TM} Peak On-State Voltage at Max Rated RMS Current T_C = 25˚C (3)	V_{GT} DC Gate-Trigger Voltage V_D = 12VDC R_L = 60Ω (8) Volts T_C = 25˚C	V_{GT} T_C = 125˚C
	See "Package Dimensions" section for variations.				Amps		Volts	mAmps		mAmps			Volts	Volts	
					MAX	MAX	MIN	MIN	MAX		MAX		MAX	MAX	MIN
1.0 Amp	S051E				1.0	0.64	50	1	10	.01	0.2	0.5	1.6	1.5	0.2
	S101E				1.0	0.64	100	1	10	.01	0.2	0.5	1.6	1.5	0.2
	S201E				1.0	0.64	200	1	10	.01	0.2	0.5	1.6	1.5	0.2
	S401E				1.0	0.64	400	1	10	.01	0.2	0.5	1.6	1.5	0.2
	S601E				1.0	0.64	600	1	10	.01	0.2	0.5	1.6	1.5	0.2
6.0 Amps		S0506L	S0506F1		6.0	3.8	50	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S1006L	S1006F1		6.0	3.8	100	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S2006L	S2006F1		6.0	3.8	200	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S4006L	S4006F1		6.0	3.8	400	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S6006L	S6006F1		6.0	3.8	600	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S8006L			6.0	3.8	800	1	15	.01	0.2	0.5	1.6	1.5	0.2
8.0 Amps		S0508L	S0508F1	S0508R	8.0	5.1	50	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S1008L	S1008F1	S1008R	8.0	5.1	100	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S2008L	S2008F1	S2008R	8.0	5.1	200	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S4008L	S4008F1	S4008R	8.0	5.1	400	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S6008L	S6008F1	S6008R	8.0	5.1	600	1	15	.01	0.2	0.5	1.6	1.5	0.2
		S8008L		S8008R	8.0	5.1	800	1	15	.01	0.2	0.5	1.6	1.5	0.2

General Notes

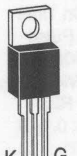
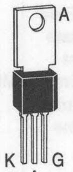
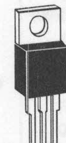
- All measurements are made at 60Hz with a resistive load at an ambient temperature of +25°C unless otherwise specified.
- Operating temperature range (T_J) is -65°C to +125°C for TO-92 devices and -40°C to +125°C for all other packages.
- Storage temperature range (T_S) is -65°C to +150°C for TO-92 devices, -40°C to +150°C for TO-202 and TO-220 devices, -40°C to +125°C for all others.
- Lead solder temperature is a maximum of 230°C for 10 seconds maximum; 1/16" (1.59mm) from case.
- The case temperature (T_C) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.

Electrical Specification Notes

(1) See Figures 6.5 through 6.16 for current rating at specified operating case temperature.
(2) See Figures 6.1 and 6.2 for free air current rating.
(3) See Figures 6.19 and 6.20 for instantaneous on-state current vs on-state voltage (typical).
(4) See Figure 6.18 for I_{GT} vs T_C.
(5) See Figure 6.17 for I_H vs T_C.
(6) For more than one full cycle rating, see Figure 6.23.
(7) See Figure 6.22 for t_{gt} vs I_{GT}.
(8) See Figure 6.21 for V_{GT} vs T_C.
(9) Test conditions are as follows: I_T = 1A for 1.0A devices and 2A for all other devices. Pulse duration = 50µs, dv/dt = 20V/µs, di/dt = -10A/µs for 1.0A devices, and -30A/µS for other devices. I_{GT} = 200mA at turn-on.
(10) See Figures 6.5 through 6.10 for maximum allowable case temperatures at maximum rated current.
(11) Pulse width ≤ 10µs.
(12) Initial on-state current = 200mA(DC) for 1A through 16A devices; 400mA(DC) for 20A through 70A devices.
(13) T_C = T_J for test conditions in off-state.

I_H	I_{GM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt		I^2t	di/dt	t_{gt}	t_q
DC Holding Current Gate Open (5) (12)	Peak Gate Current (11)	Peak Gate Power Dissipation (11)	Average Gate Power Dissipation	Peak One Cycle Surge Forward Current (6) (10)		Critical Rate of Applied Forward Voltage		RMS Surge (Non-Repetitive) On-State Current for a Period of 8.3 ms for Fusing	Maximum Rate-of-Rise of On-State Current I_{GT} = 150mA with 0.1µs Rise Time	Gate Controlled Turn-On Time Gate Pulse = 100mA Minimum Width=15µS with Rise Time ≤ 0.1µS (7)	Circuit Commutated Turn-Off Time (9) (10)
				Amps		Volts/µS					
						T_C = 100˚C	T_C = 125˚C				
mAmps	Amps	Watts	Watts	60Hz	50Hz			Amps²Sec	Amps/µSec	µSec	µSec
MAX						MIN	MIN			TYP	MAX
30	1.5	15	0.3	30	25	40	30	3.7	50	2.0	35
30	1.5	15	0.3	30	25	40	30	3.7	50	2.0	35
30	1.5	15	0.3	30	25	40	20	3.7	50	2.0	35
30	1.5	15	0.3	30	25	40	20	3.7	50	2.0	35
30	1.5	15	0.3	30	25	40	20	3.7	50	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	300	225	41	100	2.0	35
30	2.0	20	0.5	100	83	250	200	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	300	225	41	100	2.0	35
30	2.0	20	0.5	100	83	250	200	41	100	2.0	35

Electrical Specifications

TYPE	Part Number: Isolated	Part Number: Non-Isolated	Part Number: Non-Isolated	I_T Maximum On-State Current (1) Amps		V_{DRM} & V_{RRM} Repetitive Peak Off-State Forward and Reverse Voltage	I_{GT} DC Gate Trigger Current V_D = 12VDC R_L = 60Ω (4)		I_{DRM} & I_{RRM} Peak Off-State Forward and Reverse Current at V_{DRM} & V_{RRM} (13) mAmps			V_{TM} Peak On-State Voltage at Max Rated RMS Current T_C = 25˚C (3)	V_{GT} DC Gate Trigger Voltage V_D = 12VDC R_L = 60Ω (8) Volts	
	 K A G TO-220AB	 A K A G TO-202AB	 A K A G TO-220AB	$I_{T(RMS)}$	$I_{T(AV)}$	Volts	mAmps		T_C = 25˚C	T_C = 100˚C	T_C = 125˚C	Volts	T_C = 25˚C	T_C = 125˚C
	See "Package Dimensions" section for variations.			MAX	MAX	MIN	MIN	MAX	MAX			MAX	MAX	MIN
10.0 Amps	S0510L	S0510F1		10	6.4	50	1	15	.01	0.2	0.5	1.6	1.5	0.2
	S1010L	S1010F1		10	6.4	100	1	15	.01	0.2	0.5	1.6	1.5	0.2
	S2010L	S2010F1		10	6.4	200	1	15	.01	0.2	0.5	1.6	1.5	0.2
	S4010L	S4010F1		10	6.4	400	1	15	.01	0.2	0.5	1.6	1.5	0.2
	S6010L	S6010F1		10	6.4	600	1	15	.01	0.2	0.5	1.6	1.5	0.2
	S8010L			10	6.4	800	1	15	.02	0.5	1.0	1.6	1.5	0.2
			S0510R	10	6.4	50	1	15	.01	0.2	1.0	1.6	1.5	0.2
			S1010R	10	6.4	100	1	15	.01	0.2	1.0	1.6	1.5	0.2
			S2010R	10	6.4	200	1	15	.01	0.2	1.0	1.6	1.5	0.2
			S4010R	10	6.4	400	1	15	.01	0.2	1.0	1.6	1.5	0.2
			S6010R	10	6.4	600	1	15	.01	0.2	1.0	1.6	1.5	0.2
			S8010R	10	6.4	800	1	15	.02	0.5	1.0	1.6	1.5	0.2
12.0 Amps			S0512R	12	7.6	50	1	20	.01	0.5	1.0	1.6	1.5	0.2
			S1012R	12	7.6	100	1	20	.01	0.5	1.0	1.6	1.5	0.2
			S2012R	12	7.6	200	1	20	.01	0.5	1.0	1.6	1.5	0.2
			S4012R	12	7.6	400	1	20	.01	0.5	1.0	1.6	1.5	0.2
			S6012R	12	7.6	600	1	20	.01	0.5	1.0	1.6	1.5	0.2
			S8012R	12	7.6	800	1	20	.02	0.5	1.0	1.6	1.5	0.2
15.0 Amps	S0515L			15	9.5	50	1	30	.01	0.5	1.0	1.6	1.5	0.2
	S1015L			15	9.5	100	1	30	.01	0.5	1.0	1.6	1.5	0.2
	S2015L			15	9.5	200	1	30	.01	0.5	1.0	1.6	1.5	0.2
	S4015L			15	9.5	400	1	30	.01	0.5	1.0	1.6	1.5	0.2
	S6015L			15	9.5	600	1	30	.01	0.5	1.0	1.6	1.5	0.2
	S8015L			15	9.5	800	1	30	.02	1.0	2.0	1.6	1.5	0.2
16.0 Amps			S0516R	16	10	50	1	30	.01	0.5	1.0	1.6	1.5	0.2
			S1016R	16	10	100	1	30	.01	0.5	1.0	1.6	1.5	0.2
			S2016R	16	10	200	1	30	.01	0.5	1.0	1.6	1.5	0.2
			S4016R	16	10	400	1	30	.01	0.5	1.0	1.6	1.5	0.2
			S6016R	16	10	600	1	30	.01	0.5	1.0	1.6	1.5	0.2
			S8016R	16	10	800	1	30	.02	1.0	2.0	1.6	1.5	0.2

General Notes

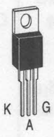
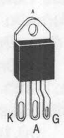
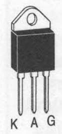
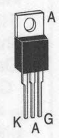
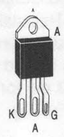
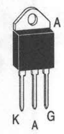
- All measurements are made at 60Hz with a resistive load at an ambient temperature of +25°C unless otherwise specified.
- Operating temperature range (T_J) is -65°C to +125°C for TO-92 devices and -40°C to +125°C for all other packages.
- Storage temperature range (T_S) is -65°C to +150°C for TO-92 devices, -40°C to +150°C for TO-202 and TO-220 devices, -40°C to +125°C for all others.
- Lead solder temperature is a maximum of 230°C for 10 seconds maximum; 1/16" (1.59mm) from case.
- The case temperature (T_C) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.

I_H	I_{GM}	P_{GM}	$P_{G(AV)}$	I_{TSM}		dv/dt		I^2t	di/dt	t_{gt}	t_q
DC Holding Current Gate Open (5) (12)	Peak Gate Current (11)	Peak Gate Power Dissipation (11)	Average Gate Power Dissipation	Peak One Cycle Surge Forward Current (6) (10) (15) Amps		Critical Rate-of-Applied Forward Voltage Volts/µSec		RMS Surge (Non-Repetitive) On-State Current for a Period of 8.3 ms for Fusing	Maximum Rate-of-Change of On-State Current I_{GT} = 150mA with 0.1µs Rise Time	Gate Controlled Turn-On Time Gate Pulse = 100mA Min. Width = 15µs with Rise Time ≤ 0.1µs (7)	Circuit Commutated Turn-Off Time (9) (10)
mAmps	Amps	Watts	Watts	60Hz	50Hz	T_C = 100°C	T_C = 125°C	Amps²Sec	Amps/µSec	µSec	µSec
MAX						MIN	MIN			TYP	MAX
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	300	225	41	100	2.0	35
30	2.0	20	0.5	100	83	250	200	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	350	250	41	100	2.0	35
30	2.0	20	0.5	100	83	300	225	41	100	2.0	35
30	2.0	20	0.5	100	83	250	200	41	100	2.0	35
40	2.0	20	0.5	120	100	350	250	60	100	2.0	35
40	2.0	20	0.5	120	100	350	250	60	100	2.0	35
40	2.0	20	0.5	120	100	350	250	60	100	2.0	35
40	2.0	20	0.5	120	100	350	250	60	100	2.0	35
40	2.0	20	0.5	120	100	300	225	60	100	2.0	35
40	2.0	20	0.5	120	100	250	200	60	100	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	425	325	210	125	2.0	35
40	3.0	30	0.6	225	188	400	300	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	450	350	210	125	2.0	35
40	3.0	30	0.6	225	188	425	325	210	125	2.0	35
40	3.0	30	0.6	225	188	400	300	210	125	2.0	35

Electrical Specification Notes

(1) See Figures 6.5 through 6.16 for current rating at specified operating case temperature.
(2) See Figures 6.1 and 6.2 for free air current rating.
(3) See Figures 6.19 and 6.20 for instantaneous on-state current vs on-state voltage (typical).
(4) See Figure 6.18 for I_{GT} vs T_C.
(5) See Figure 6.17 for I_H vs T_C.
(6) For more than one full cycle rating, see Figure 6.23.
(7) See Figure 6.22 for t_{gt} vs I_{GT}.
(8) See Figure 6.21 for V_{GT} vs T_C.
(9) Test conditions are as follows: i_T = 1A for 1.0A devices and 2A for all other devices. Pulse duration = 50µs, dv/dt = 20V/µs, di/dt = -10A/µs for 1.0A devices, and -30A/µs for other devices. I_{GT} = 200mA at turn-on.
(10) See Figures 6.5 through 6.10 for maximum allowable case temperatures at maximum rated current.
(11) Pulse width ≤ 10µs.
(12) Initial on-state current = 200mA(DC) for 1 through 16A devices; 400mA(DC) for 20A through 70A devices.
(13) $T_C = T_J$ for test conditions in off-state.
(14) The "R", "K" or "M" package rating is intended for high surge condition use only and not recommended for ≥50A(RMS) continuous current use since narrow pin lead temperature can exceed PCB solder melting temperature. Recommend for ≥50A(RMS) continuous current requirements, Teccor's "J" or "W" package.
(15) For various durations of an exponentially decaying current waveform, see Figures 6.3 and 6.4. (t_w is defined as 5 time constants.)

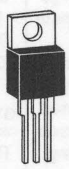
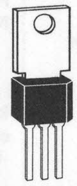
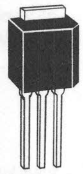
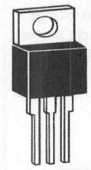
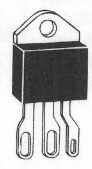
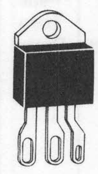
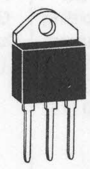
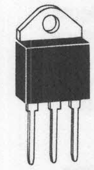
Electrical Specifications

TYPE	Part Number: Isolated			Part Number: Non-Isolated			I_T Maximum On-State Current (1) (14)		V_{DRM} & V_{RRM} Repetitive Peak Off-State Forward and Reverse Voltage	I_{GT} DC Gate Trigger Current V_D = 12VDC R_L = 30Ω (4)		I_{DRM} & I_{RRM} Peak Off-State Forward and Reverse Current at V_{DRM} and V_{RRM} (13)			V_{TM} Peak On-State Voltage at Max Rated RMS Current T_C = 25°C (3)
	 TO 220AB	 TO 218X	 TO 218AC	 TO 220AB	 TO 218X	 TO 218AC	Amps					mAmps			
							$I_{T(RMS)}$	$I_{T(AV)}$	Volts	mAmps		T_C = 25°C	T_C = 100°C	T_C = 125°C	Volts
	See "Package Dimensions" section for variations.						MAX		MIN	MIN	MAX	MAX			MAX
20 Amps	S0520L						20	12.8	50	1	30	.01	0.5	1.0	1.6
	S1020L						20	12.8	100	1	30	.01	0.5	1.0	1.6
	S2020L						20	12.8	200	1	30	.01	0.5	1.0	1.6
	S4020L						20	12.8	400	1	30	.01	0.5	1.0	1.6
	S6020L						20	12.8	600	1	30	.01	0.5	1.0	1.6
	S8020L						20	12.8	800	1	30	.02	1.0	2.0	1.6
25 Amps	S0525L			S0525R			25	16	50	1	35	.01	1.0	2.0	1.6
	S1025L			S1025R			25	16	100	1	35	.01	1.0	2.0	1.6
	S2025L			S2025R			25	16	200	1	35	.01	1.0	2.0	1.6
	S4025L			S4025R			25	16	400	1	35	.01	1.0	2.0	1.6
	S6025L			S6025R			25	16	600	1	35	.01	1.0	2.0	1.6
	S8025L			S8025R			25	16	800	1	35	.02	1.5	3.0	1.6
35 Amps		S0535J	S0535K				35	22	50	5	40	.01	1.0	2.0	1.8
		S1035J	S1035K				35	22	100	5	40	.01	1.0	2.0	1.8
		S2035J	S2035K				35	22	200	5	40	.01	1.0	2.0	1.8
		S4035J	S4035K				35	22	400	5	40	.01	1.0	2.0	1.8
		S6035J	S6035K				35	22	600	5	40	.01	1.0	2.0	1.8
		S8035J	S8035K				35	22	800	5	40	.02	1.5	3.0	1.8
40 Amps				S0540R			40	25	50	5	40	.01	1.0	2.0	1.8
				S1040R			40	25	100	5	40	.01	1.0	2.0	1.8
				S2040R			40	25	200	5	40	.01	1.0	2.0	1.8
				S4040R			40	25	400	5	40	.01	1.0	2.0	1.8
				S6040R			40	25	600	5	40	.01	1.0	2.0	1.8
				S8040R			40	25	800	5	40	.02	1.5	3.0	1.8
55 Amps				S0555R	S0555W	S0555M	55	35	50	5	40	.01	1.0	2.0	1.8
				S1055R	S1055W	S1055M	55	35	100	5	40	.01	1.0	2.0	1.8
				S2055R	S2055W	S2055M	55	35	200	5	40	.01	1.0	2.0	1.8
				S4055R	S4055W	S4055M	55	35	400	5	40	.01	1.0	2.0	1.8
				S6055R	S6055W	S6055M	55	35	600	5	40	.01	1.0	2.0	1.8
				S8055R	S8055W	S8055M	55	35	800	5	40	.02	1.5	3.0	1.8
65 Amps		S0565J	S0565K				65	41	50	5	50	.02	1.5	3.0	1.8
		S1065J	S1065K				65	41	100	5	50	.02	1.5	3.0	1.8
		S2065J	S2065K				65	41	200	5	50	.02	1.5	3.0	1.8
		S4065J	S4065K				65	41	400	5	50	.02	1.5	3.0	1.8
		S6065J	S6065K				65	41	600	5	50	.02	1.5	3.0	1.8
		S8065J	S8065K				65	41	800	5	50	.02	2.0	5.0	1.8
70 Amps					S0570W		70	45	50	5	50	.02	1.5	3.0	1.8
					S1070W		70	45	100	5	50	.02	1.5	3.0	1.8
					S2070W		70	45	200	5	50	.02	1.5	3.0	1.8
					S4070W		70	45	400	5	50	.02	1.5	3.0	1.8
					S6070W		70	45	600	5	50	.02	1.5	3.0	1.8
					S8070W		70	45	800	5	50	.02	2.0	5.0	1.8

See General Notes and Electrical Specification Notes on pages 6-4 and 6-5.

V_{GT} DC Gate Trigger Voltage V_D = 12VDC R_L = 30Ω (8) Volts		I_H DC Holding Current Gate Open (5) (12)	I_{GM} Peak Gate Current (11)	P_{GM} Peak Gate Power Dissipation (11)	$P_{G(AV)}$ Average Gate Power Dissipation	I_{TSM} Peak One Cycle Surge Forward Current (6) (10) (15) Amps		dv/dt Critical Rate-of-Applied Forward Voltage Volts/µSec		I^2t RMS Surge (Non-Repetitive) On-State Current for a Period of 8.3 msec for Fusing	di/dt Maximum Rate-of-Change of On-State Current I_{GT} = 150mA with 0.1µS Rise Time	t_{gt} Gate Controlled Turn-On Time Gate Pulse = 150mA Min. Width = 15µS with Rise Time ≤ 0.1µS (7)	t_q Circuit Commutated Turn-Off Time (9) (10)
T_C = 25°C	T_C = 125°C	mAmps	Amps	Watts	Watts	60 Hz	50 Hz	T_C = 100°C	T_C = 125°C	$Amps^2Sec$	Amps/µSec	µSec	µSec
MAX	MIN	MAX						MIN	MIN			TYP	MAX
1.5	0.2	40	3.0	30	0.6	300	255	450	350	374	125	2.0	35
1.5	0.2	40	3.0	30	0.6	300	255	450	350	374	125	2.0	35
1.5	0.2	40	3.0	30	0.6	300	255	450	350	374	125	2.0	35
1.5	0.2	40	3.0	30	0.6	300	255	450	350	374	125	2.0	35
1.5	0.2	40	3.0	30	0.6	300	255	425	325	374	125	2.0	35
1.5	0.2	40	3.0	30	0.6	300	255	400	300	374	125	2.0	35
1.5	0.2	50	3.5	35	0.8	350	300	450	350	510	150	2.0	35
1.5	0.2	50	3.5	35	0.8	350	300	450	350	510	150	2.0	35
1.5	0.2	50	3.5	35	0.8	350	300	450	350	510	150	2.0	35
1.5	0.2	50	3.5	35	0.8	350	300	450	350	510	150	2.0	35
1.5	0.2	50	3.5	35	0.8	350	300	425	325	510	150	2.0	35
1.5	0.2	50	3.5	35	0.8	350	300	400	300	510	150	2.0	35
1.5	0.2	50	3.5	35	0.8	500	425	450	350	1035	150	2.0	35
1.5	0.2	50	3.5	35	0.8	500	425	450	350	1035	150	2.0	35
1.5	0.2	50	3.5	35	0.8	500	425	450	350	1035	150	2.0	35
1.5	0.2	50	3.5	35	0.8	500	425	450	350	1035	150	2.0	35
1.5	0.2	50	3.5	35	0.8	500	425	425	325	1035	150	2.0	35
1.5	0.2	50	3.5	35	0.8	500	425	400	300	1035	150	2.0	35
1.5	0.2	60	3.5	35	0.8	520	430	650	550	1122	175	2.5	35
1.5	0.2	60	3.5	35	0.8	520	430	650	550	1122	175	2.5	35
1.5	0.2	60	3.5	35	0.8	520	430	650	550	1122	175	2.5	35
1.5	0.2	60	3.5	35	0.8	520	430	650	550	1122	175	2.5	35
1.5	0.2	60	3.5	35	0.8	520	430	600	500	1122	175	2.5	35
1.5	0.2	60	3.5	35	0.8	520	430	500	475	1122	175	2.5	35
1.5	0.2	60	4.0	40	0.8	650	550	650	550	1750	175	2.5	35
1.5	0.2	60	4.0	40	0.8	650	550	650	550	1750	175	2.5	35
1.5	0.2	60	4.0	40	0.8	650	550	650	550	1750	175	2.5	35
1.5	0.2	60	4.0	40	0.8	650	550	650	550	1750	175	2.5	35
1.5	0.2	60	4.0	40	0.8	650	550	600	500	1750	175	2.5	35
1.5	0.2	60	4.0	40	0.8	650	550	500	475	1750	175	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	600	500	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	500	475	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	650	550	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	600	500	3745	200	2.5	35
2.0	0.2	80	5.0	50	1.0	950	800	500	475	3745	200	2.5	35

See General Notes and Electrical Specification Notes on pages 6-4 and 6-5.

THERMAL RESISTANCE (STEADY STATE) $R_{\theta JC}$ [$R_{\theta JA}$] ˚C/W (TYP.)									
	E	L	F	F2	R	J	W	K	M
Type	 TO-92	 THERMOTAB TO-220AB	 Type 1 TO-202	 Type 2 TO-202	 Non-Isolated TO-220AB	 Isolated TO-218X	 Non-Isolated TO-218X	 Isolated TO-218AC	 Non-Isolated TO-218AC
1.0 Amp	50 [145]								
6.0 Amps		4.0 [50]	4.3	9.5 [70]					
8.0 Amps		3.4	3.9		2.1 [40]				
10.0 Amps		3.0	3.4		1.9				
12.0 Amps					1.7				
15.0 Amps		2.5							
16.0 Amps					1.5				
20.0 Amps		2.4							
25.0 Amps		2.35			1.1				
35.0 Amps						.70		.70	
40.0 Amps					0.66				
55.0 Amps					0.58		.53		.53
65.0 Amps						.86		.86	
70.0 Amps							.60		

Electrical Isolation

Teccor's isolated SCR packages will withstand a minimum high potential test of 2500VAC(RMS) from leads to mounting tab over the device's operating temperature range. See table below for standard and optional isolation ratings.

Electrical Isolation from Leads to Mounting Tab			
VAC(RMS)	Isolated ** TO-220AB	Isolated ** TO-218X	Isolated ** TO-218AC
2500	**Standard**	**Standard**	**Standard**
4000	**Optional ***	**N/A**	**N/A**

*For 4000V isolation, add "V" suffix to part number.
**UL Recognized File #E71639.

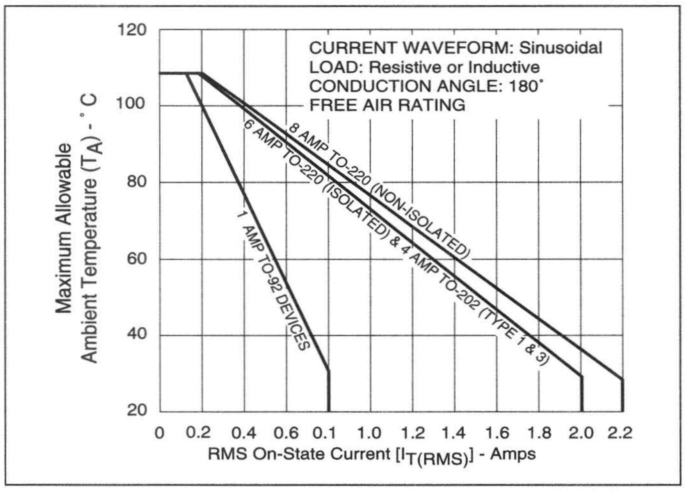


Figure 6.1 Maximum Allowable Ambient Temperature vs RMS On-State Current

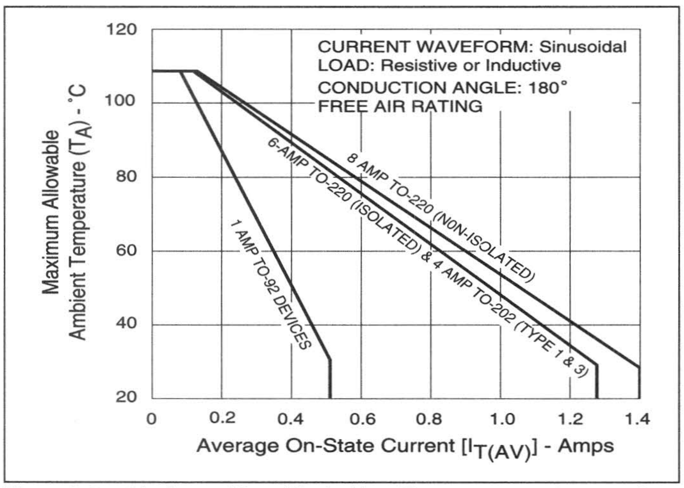


Figure 6.2 Maximum Allowable Ambient Temperature vs Average On-State Current

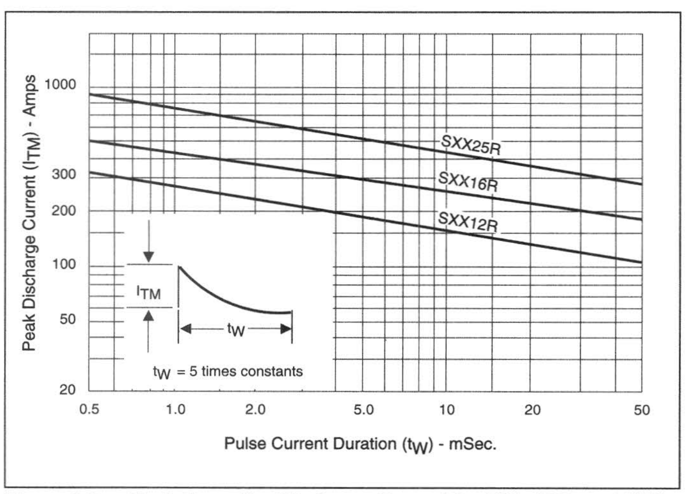


Figure 6.3 Peak Capacitor Discharge Current for 12R, 16R, and 25R

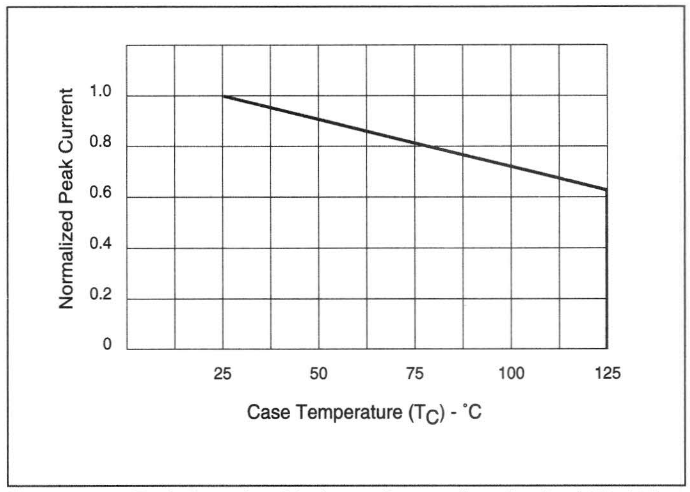


Figure 6.4 Peak Capacitor Discharge Current Derating for 12R, 16R, and 25R

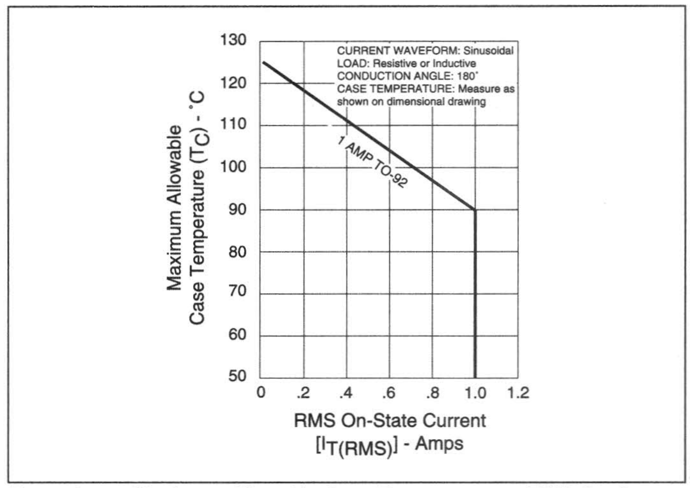


Figure 6.5 Maximum Allowable Case Temperature vs RMS On-State Current (TO-92, 1 Amp)

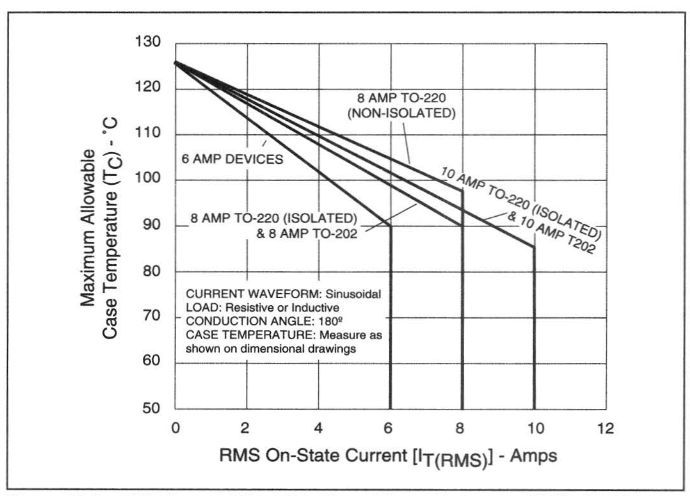


Figure 6.6 Maximum Allowable Case Temperature vs RMS On-State Current (6, 8, and 10 Amps)

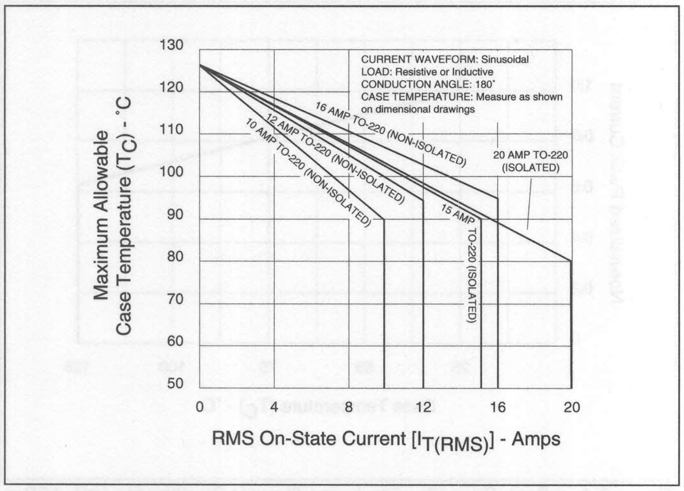


Figure 6.7 Maximum Allowable Case Temperature vs RMS On-State Current (10, 12, 16, and 20 Amps)

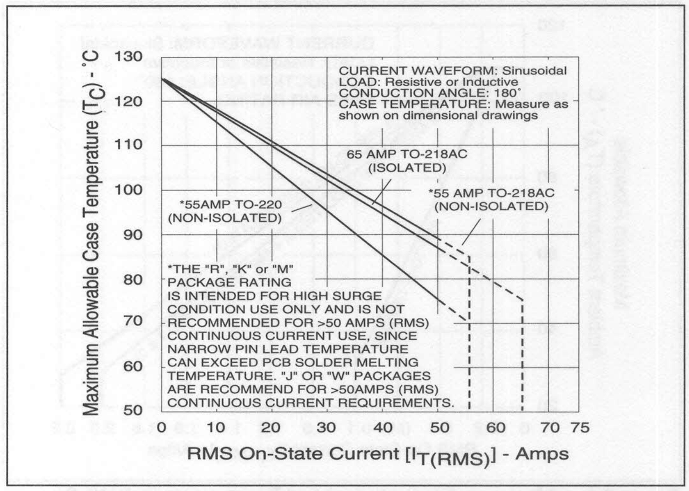


Figure 6.10 Maximum Allowable Case Temperature vs RMS On-State Current (55 and 65 Amps)

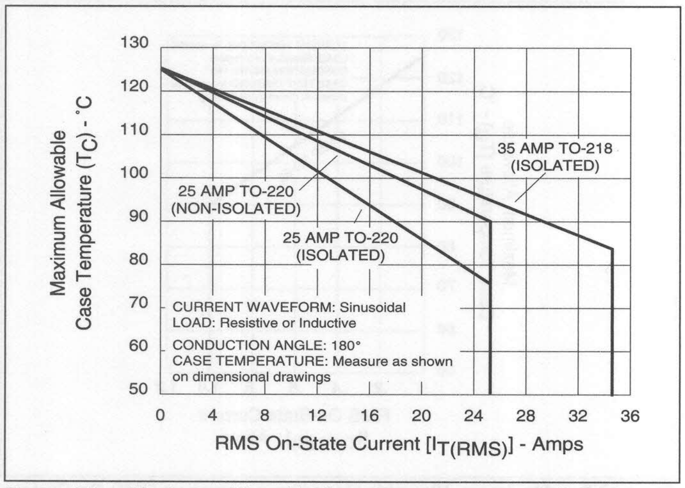


Figure 6.8 Maximum Allowable Case Temperature vs RMS On-State Current (25 and 35 Amps)

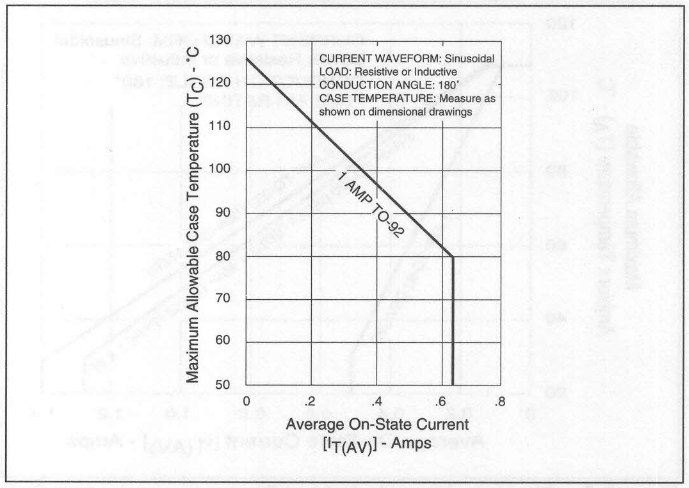


Figure 6.11 Maximum Allowable Case Temperature vs Average On-State Current (TO-92, 1 Amp)

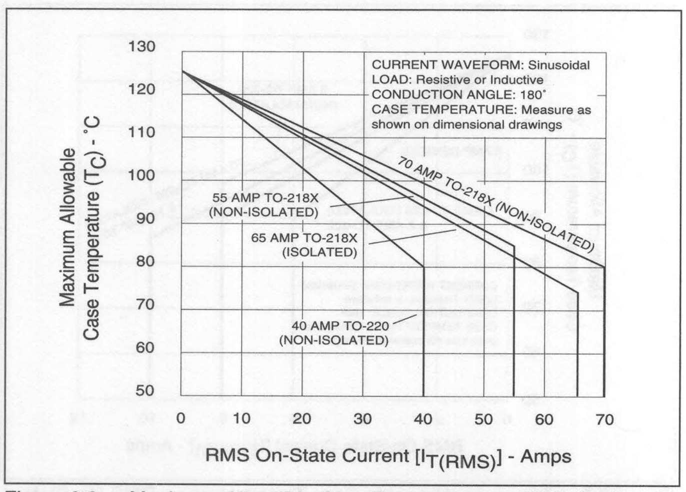


Figure 6.9 Maximum Allowable Case Temperature vs RMS On-State Current (40-70 Amps)

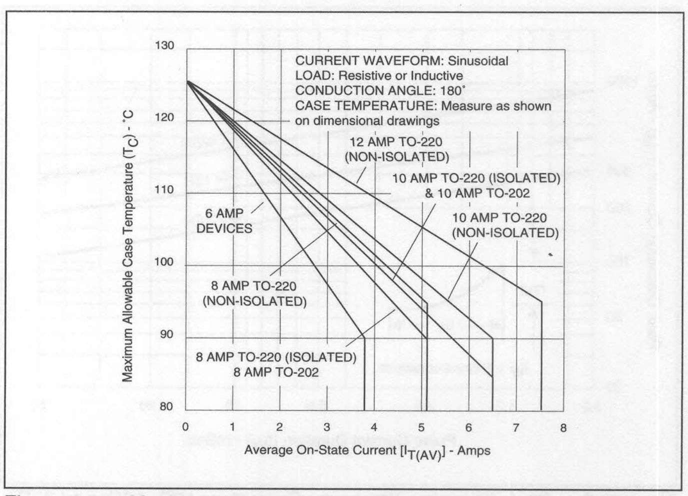


Figure 6.12 Maximum Allowable Case Temperature vs Average On-State Current (8, 10, and 12 Amps)

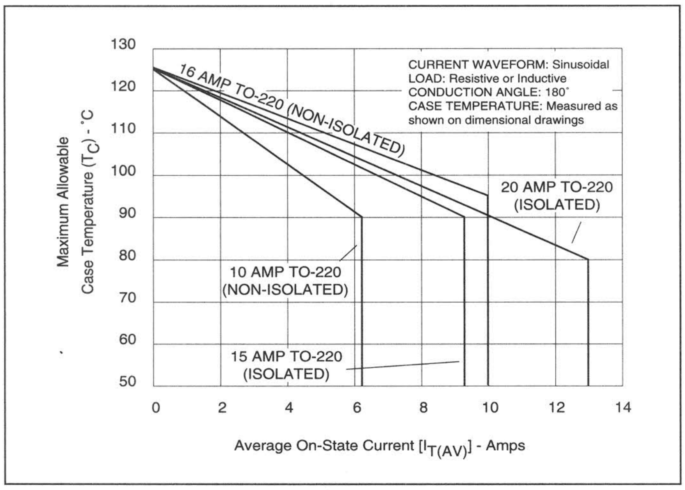


Figure 6.13 Maximum Allowable Case Temperature vs Average On-State Current (10-20 Amps)

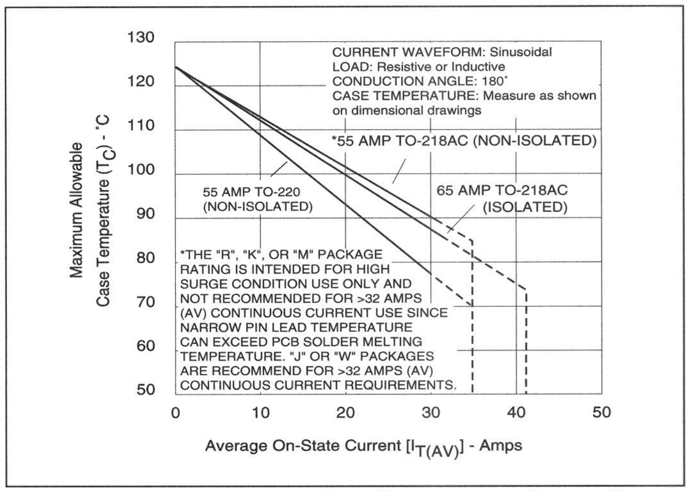


Figure 6.16 Maximum Allowable Case Temperature vs Average On-State Current (55 and 65 Amps)

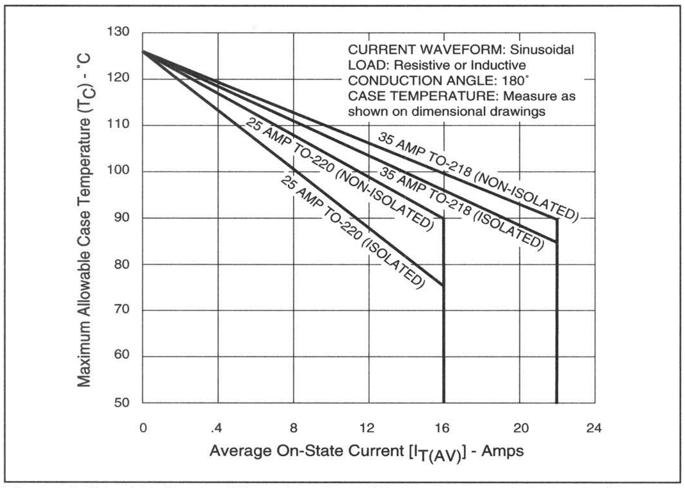


Figure 6.14 Maximum Allowable Case Temperature vs Average On-State Current (25 and 35 Amps)

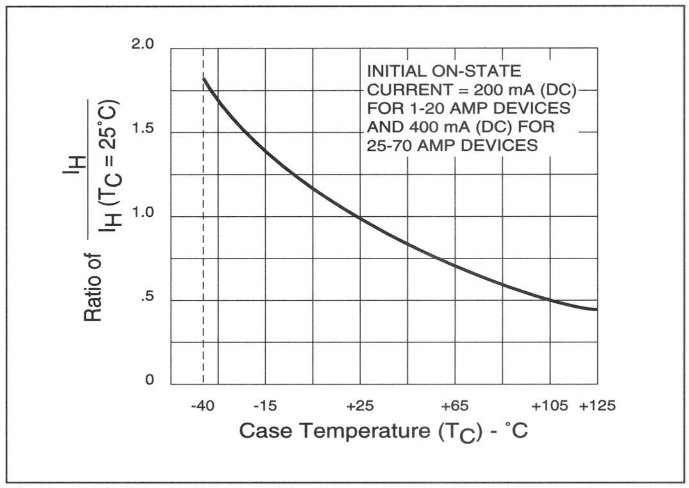


Figure 6.17 Normalized DC Holding Current vs Case Temperature

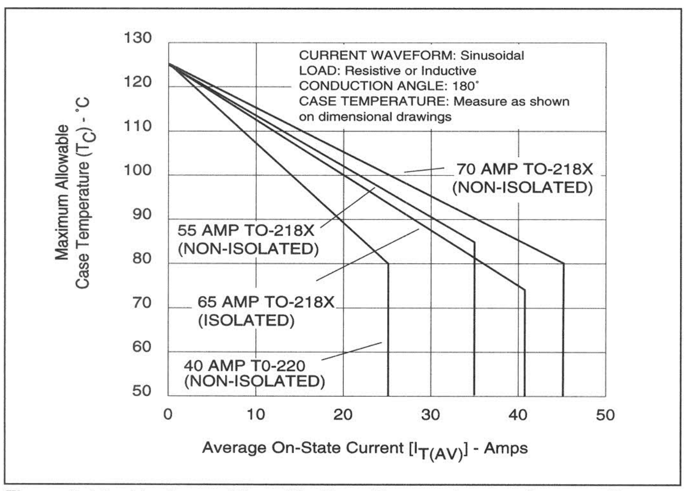


Figure 6.15 Maximum Allowable Case Temperature vs Average On-State Current (40-70 Amps)

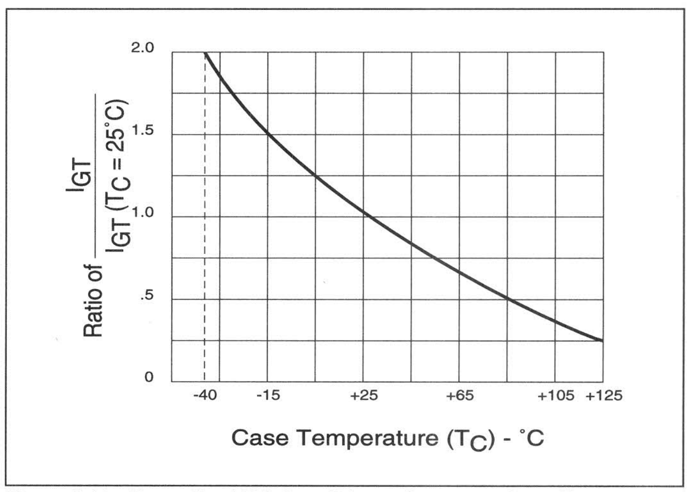


Figure 6.18 Normalized DC Gate-Trigger Current vs Case Temperature

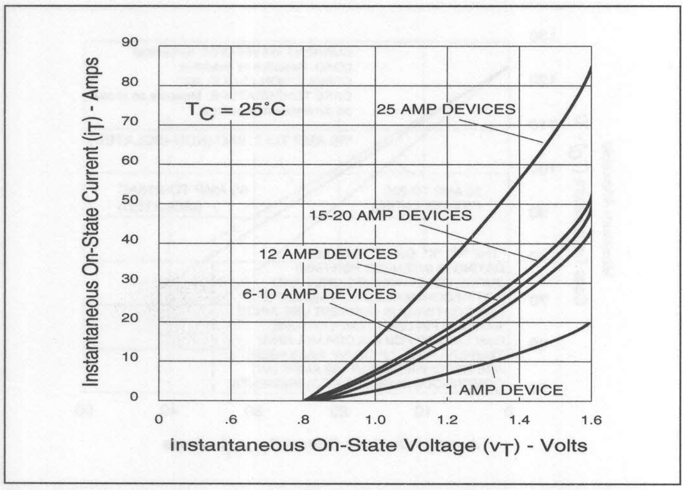


Figure 6.19 Instantaneous On-State Current vs On-State Voltage (Typical) (6-25 Amps)

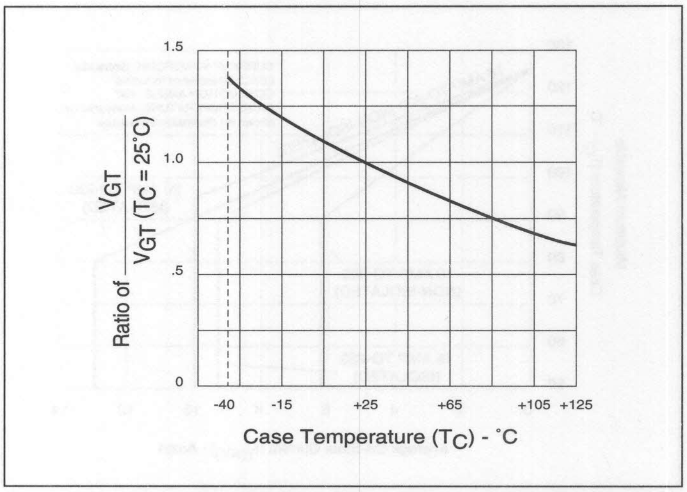


Figure 6.21 Normalized DC Gate-Trigger Voltage vs Case Temperature

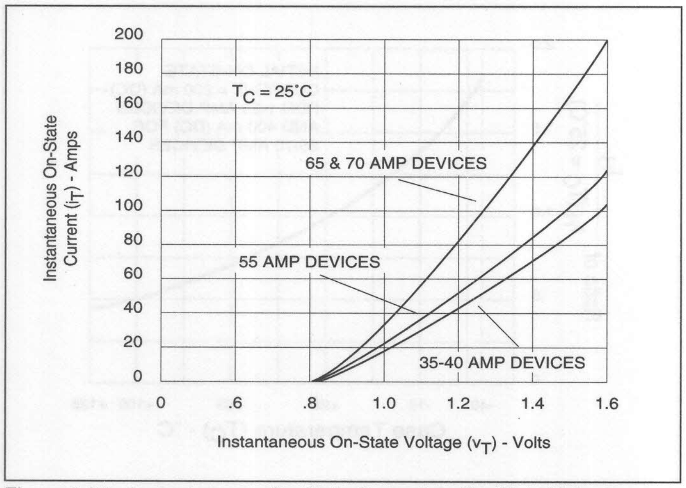


Figure 6.20 Instantaneous On-State Current vs On-State Voltage (Typical) (35-70 Amps)

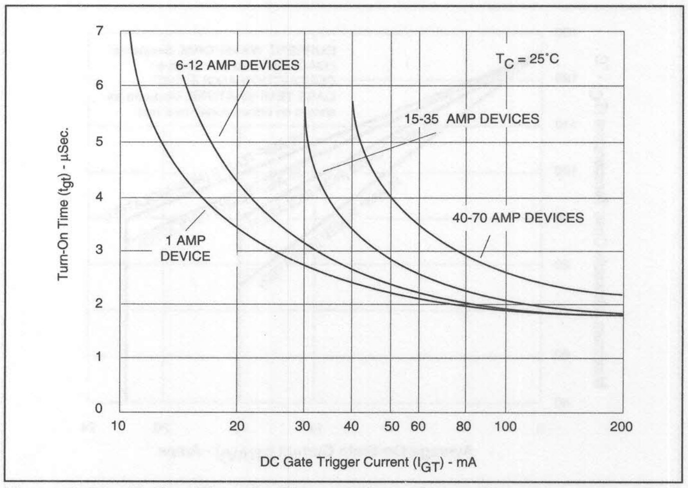


Figure 6.22 Typical Turn-On Time vs Gate-Trigger Current

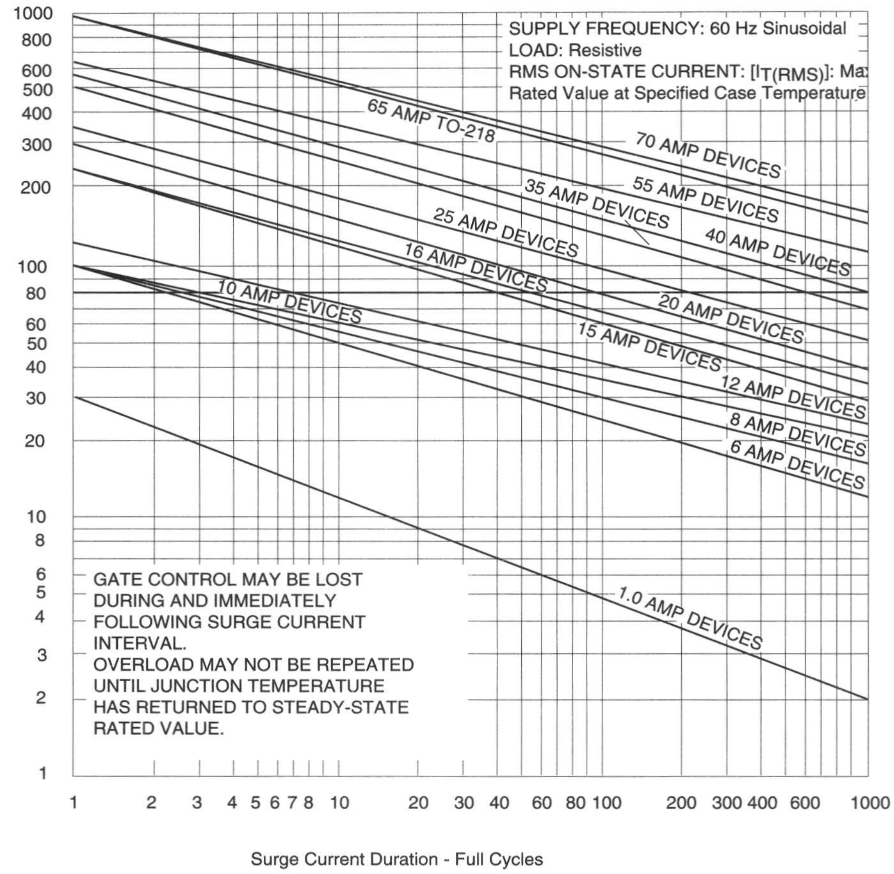


Figure 6.23 Peak Surge Current vs Surge Current Duration

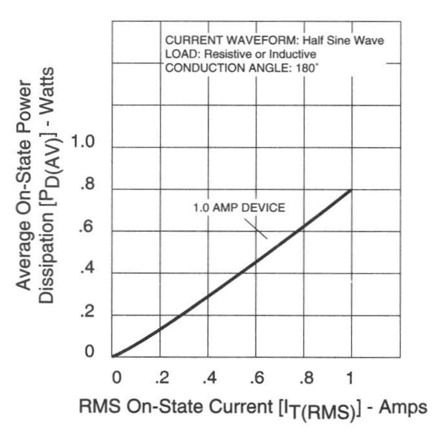


Figure 6.24 Power Dissipation (Typical) vs RMS On-State Current (TO-92, 1 Amp)

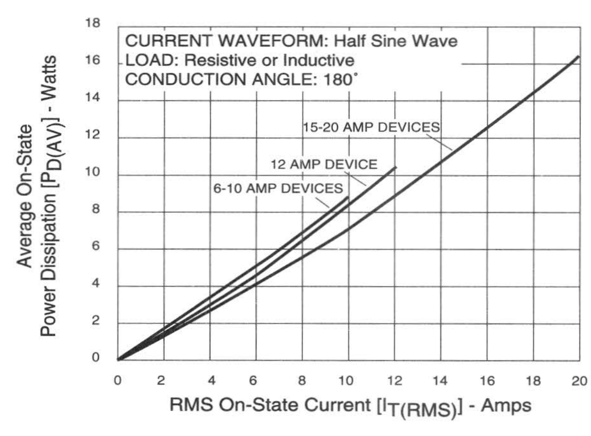


Figure 6.25 Power Dissipation (Typical) vs RMS On-State Current (6-20 Amps)

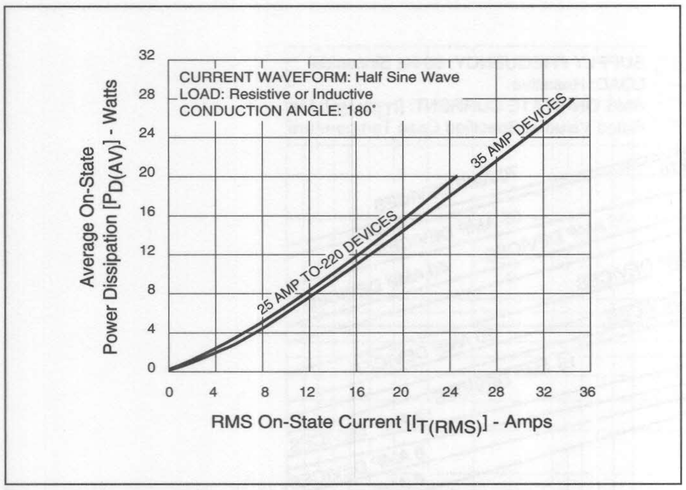


Figure 6.26 Power Dissipation (Typical) vs RMS On-State Current (25 and 35 Amps)

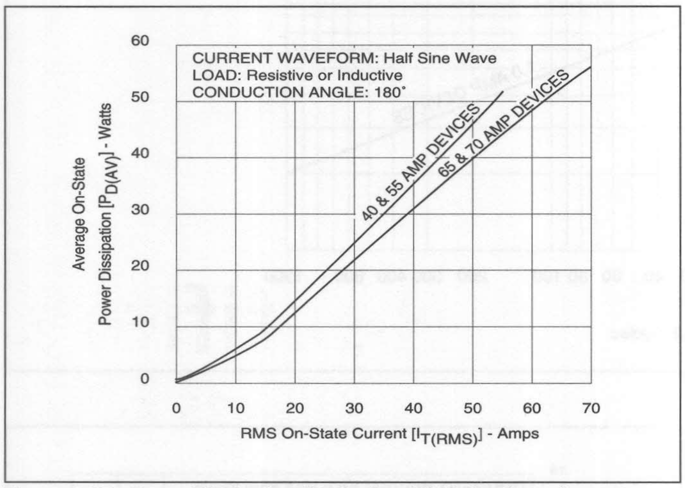
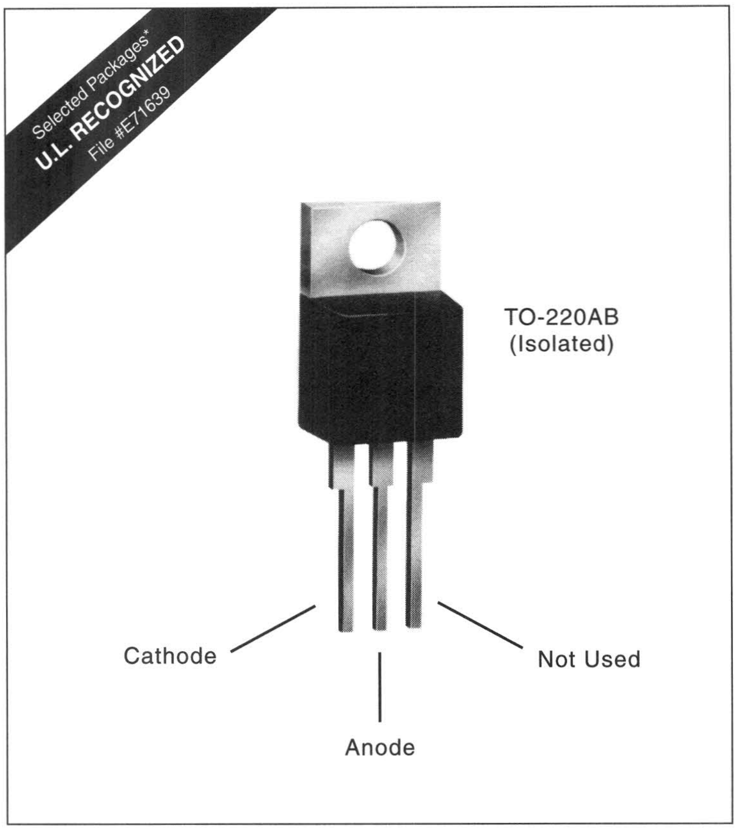
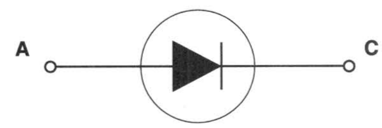


Figure 6.27 Power Dissipation (Typical) vs RMS On-State Current (40-70 Amps)





Rectifiers

(15 – 25 Amps)

General Description

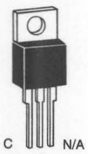
Teccor manufactures 15 to 25 ampere (RMS) rectifiers with voltages rated from 50 to 800 volts. Due to the electrically-isolated TO-220 package, these rectifiers may be used in common anode or common cathode circuits using only one part type, thereby simplifying stock requirements.

Teccor's silicon rectifiers feature glass-passivated junctions to ensure long term reliability and stability. In addition, glass offers a rugged, reliable barrier against junction contamination.

Features

- **Electrically-isolated packages**
- **High voltage capabilities (50 to 800 Volts)**
- **High surge capabilities (up to 350 Amps)**
- **Glass-passivated junctions**

Electrical Specifications

Type	Part Number	V_{RRM}	V_R	$I_{F(AV)}$	$I_{F(RMS)}$	I_{FSM}		I_{RM}			V_{FM}	I^2t	$R_{\theta JC}$
	Isolated												
Type	 C A N/A	Peak Repetitive Reverse Voltage	DC Blocking Voltage	Average Forward Current (1)	RMS Forward Current	Peak One Cycle Surge Current (2) Amps		Peak Reverse Current (3) mA			Peak Forward Voltage at Rated Average Forward Current T_C=25°C	RMS Surge (Non-Repetitive) Forward Current For 8.3ms for Fusing	Thermal Resistance (Steady State) Junction to Case
	TO-220AB	Volts	Volts	Amps	Amps	60 Hz	50Hz	T_C = 25°C	T_C = 100°C	T_C = 125°C	Volts	$Amps^2$ Sec	°C/W
	See "Package Dimensions" section for variations.	MIN	MIN	MAX	MAX				MAX		MAX		TYP
15 Amps	D0515L	50	50	9.5	15	225	188	0.1	0.5	1.0	1.6	210	2.85
	D2015L	200	200	9.5	15	225	188	0.1	0.5	1.0	1.6	210	2.85
	D4015L	400	400	9.5	15	225	188	0.1	0.5	1.0	1.6	210	2.85
	D6015L	600	600	9.5	15	225	188	0.1	0.5	1.0	1.6	210	2.58
	D8015L	800	800	9.5	15	225	188	0.1	0.5	1.0	1.6	210	2.85
20 Amps	D0520L	50	50	12.7	20	300	255	0.1	0.5	1.0	1.6	374	2.5
	D2020L	200	200	12.7	20	300	255	0.1	0.5	1.0	1.6	374	2.5
	D4020L	400	400	12.7	20	300	255	0.1	0.5	1.0	1.6	374	2.5
	D6020L	600	600	12.7	20	300	255	0.1	0.5	1.0	1.6	374	2.5
	D8020L	800	800	12.7	20	300	255	0.1	0.5	1.0	1.6	374	2.5
25 Amps	D0525L	50	50	15.9	25	350	300	0.1	0.5	1.0	1.6	508	2.7
	D2025L	200	200	15.9	25	350	300	0.1	0.5	1.0	1.6	508	2.7
	D4025L	400	400	15.9	25	350	300	0.1	0.5	1.0	1.6	508	2.7
	D6025L	600	600	15.9	25	350	300	0.1	0.5	1.0	1.6	508	2.7
	D8025L	800	800	15.9	25	350	300	0.1	0.5	1.0	1.6	508	2.7

GENERAL NOTES

- Operating temperature range (T_J) is -40°C to +125°C.
- Storage temperature range (T_S) is -40°C to +125°C.
- Lead solder temperature is a maximum of 230°C for 10 seconds maximum at a minimum of 1/16" (1.59mm) from case.
- The case temperature (T_C) is measured as shown on dimensional outline drawings. See "Package Dimensions" section of this catalog.
- Teccor's electrically-isolated TO-220 devices will withstand a high potential test of 2500VAC RMS from leads to mounting tab over the operating temperature range.
- Typical Reverse Recovery Time (t_{rr}) is 4µsec (Test conditions = 0.9A forward current and 1.5A reverse current).

NOTES TO ELECTRICAL SPECIFICATIONS

(1) See Figure 7.2 for current rating at specified case temperature.
(2) For more than one full cycle rating, see Figure 7.4.
(3) $T_C = T_J$ for test conditions.

ELECTRICAL ISOLATION FROM LEADS TO MOUNTING TAB**	
VAC(RMS)	ISOLATED TO-220AB
2500	Standard
4000	Optional*

* For 4000 V isolation use "V" suffix.
** U.L. Recognized File #E71639

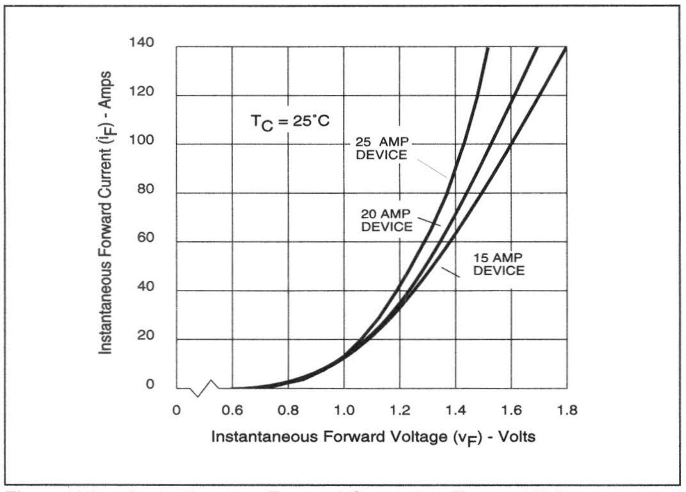


Figure 7.1 Instantaneous Forward Current vs Forward Voltage (Typical)

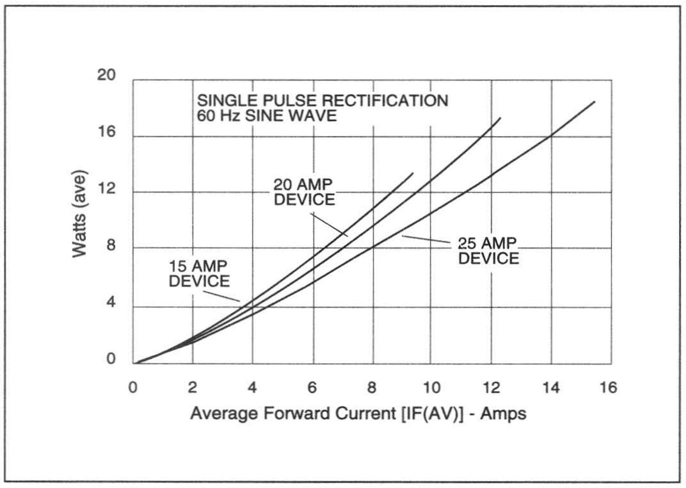


Figure 7.2 Forward Power Dissipation (Typical)

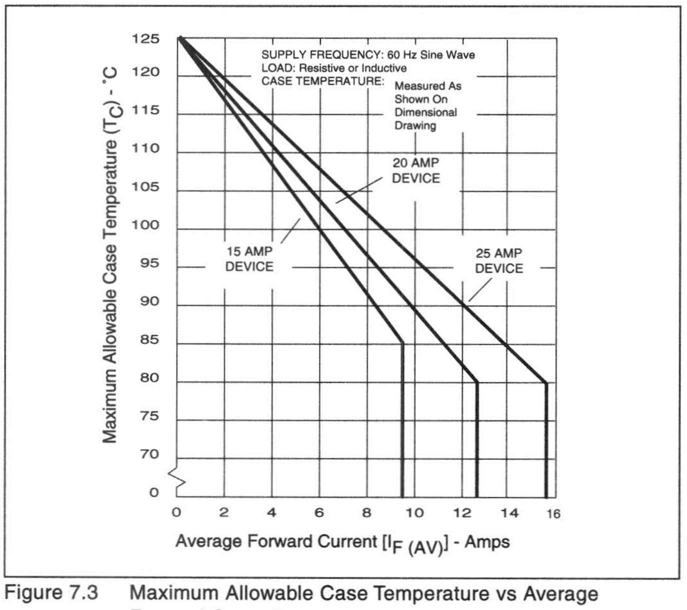


Figure 7.3 Maximum Allowable Case Temperature vs Average Forward Current

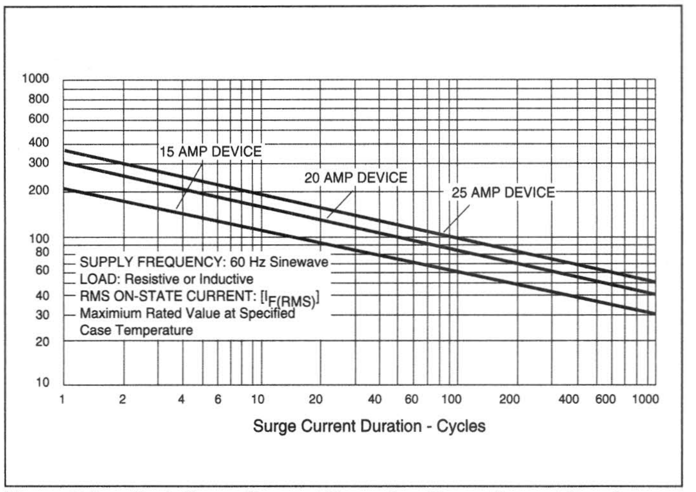
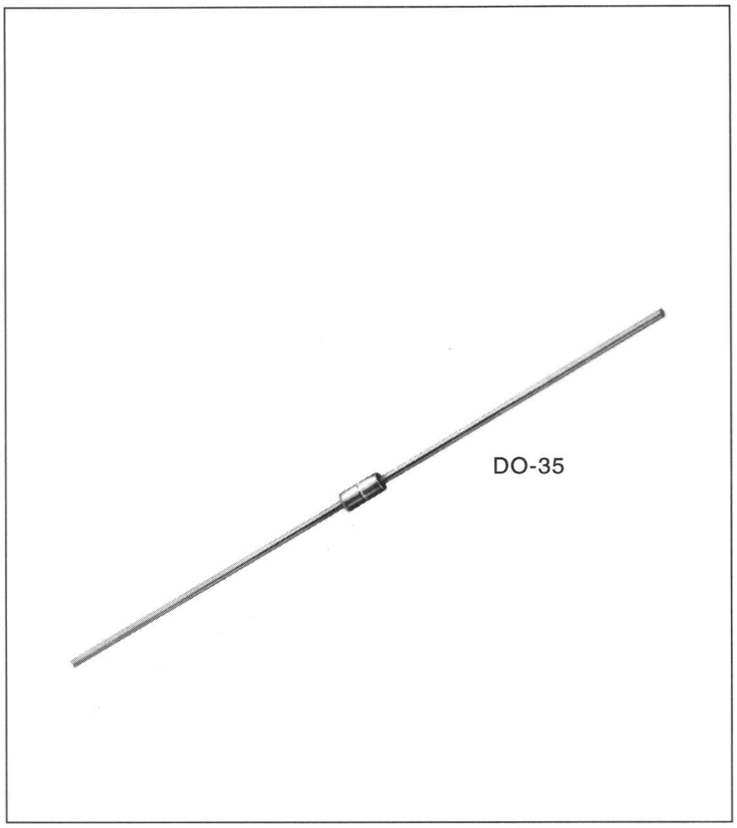
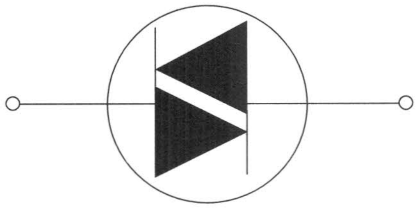


Figure 7.4 Peak Surge Forward Current vs Surge Current Duration

Notes





Bilateral Trigger Diacs

HT Series

General Description

Teccor's "HT" Series of bilateral trigger diacs offers a range of voltage characteristics from 27 to 70 volts.

The diac semiconductor is a full-wave or bidirectional thyristor. It is triggered from a blocking-to-conduction state for either polarity of applied voltage whenever the amplitude of applied voltage exceeds the breakover voltage rating of the diac.

The Teccor line of diacs features glass-passivated junctions to ensure long term device reliability and parameter stability. Teccor's glass offers a rugged, reliable barrier against junction contamination.

The diac specifications listed in this data sheet are for standard products. Special parameter selections such as close tolerance voltage symmetry are available. Please consult the factory for more information for custom design applications. Suffix RP signifies tape-and-reel packing. Example: HT32RP.

Features

- **Glass-chip passivation**
- **DO-35 trigger package**
- **Pre-tinned leads**
- **Wide voltage range selections**

Electrical Specifications

ELECTRICAL CHARACTERISTICS $T_C = 25^\circ C$						
Part Number	V_{BO} Breakover Voltage (Forward and Reverse) Volts		ΔV_{BO} Breakover Voltage Symmetry $\Delta V_{BO} = [\,\lvert +V_{BO} \rvert - \lvert -V_{BO} \rvert\,]$ Volts	V_{BB} Dynamic Breakback Voltage (3) $\lvert \Delta V\pm \rvert$ Volts	I_{BO} Peak Breakover Current at Breakover Voltage µAmps	I_{TRM} Peak Pulse Current for 10µs 120 PPS $T_A \leq 40^\circ C$ Amps
	MIN	MAX	MAX	MIN	MAX	MAX
HT-32	27	37	3 (1)	10 (2)	25	2.0
HT-32A / HT-5761	28	36	2 (1)	7 at 10mA (4)	25	2.0
HT-32B / HT-5761A	30	34	2 (1)	7 at 10mA (4)	25	2.0
HT-34B	32	36	2 (1)	10 (2)	25	2.0
HT-35	30	40	3 (1)	10 (2)	25	2.0
HT-36A / HT-5762	32	40	2 (1)	7 at 10mA (4)	25	2.0
HT-36B	34	38	2 (1)	10 (2)	25	2.0
HT-40	35	45	3 (1)	10 (2)	25	2.0
HT-60	56	70	4	20 (2)	25	1.5

General Notes

- Lead solder temperature is +230˚C max. for 10 seconds max.; ≥ 1/16" (1.59mm) from case.
- See "Package Dimensions" section of this catalog.

Electrical Specification Notes

(1) Breakover Voltage symmetry as close as 1.0V is available from factory on these products.
(2) See Figures 8.4 and 8.5 for Test Circuit and waveforms.
(3) Typical switching time is 900 nano-seconds measured at I_{PK} (see Figure 8.4) across a 20Ω resistor (see Figure 8.5). Switching time defined as rise time of I_{PK} between the 10% to 90% points.
(4) See Figure 8.7.

Bilateral Trigger DIAC Specifications

- Maximum Ratings, Absolute-Maximum Values

  Maximum Trigger Firing Capacitance: 0.1µF
  Device Dissipation (at T_A = -40˚ to +40˚C): 250mW
  Derate Above +40˚C: 3.6mW/˚C

- Temperature Ranges

  Storage: -40˚C to +125˚C
  Operating (Junction): -40˚C to +125˚C

- Thermal Resistance
  Junction to Ambient ($R_{\theta JA}$): 278˚C/W
  Junction to Lead ($R_{\theta JL}$): 100˚C/W
  (based on maximum lead temperature of 85˚C at ≤250mW)

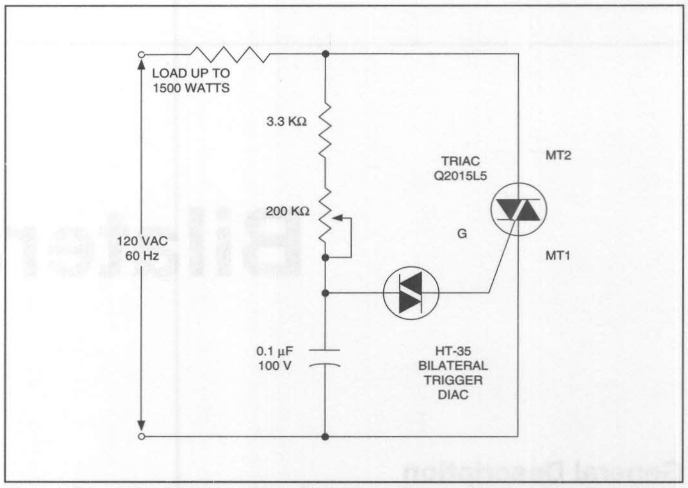


Figure 8.1 Typical Diac-Triac Full-Wave Phase Control Circuit using Lower Voltage Diacs

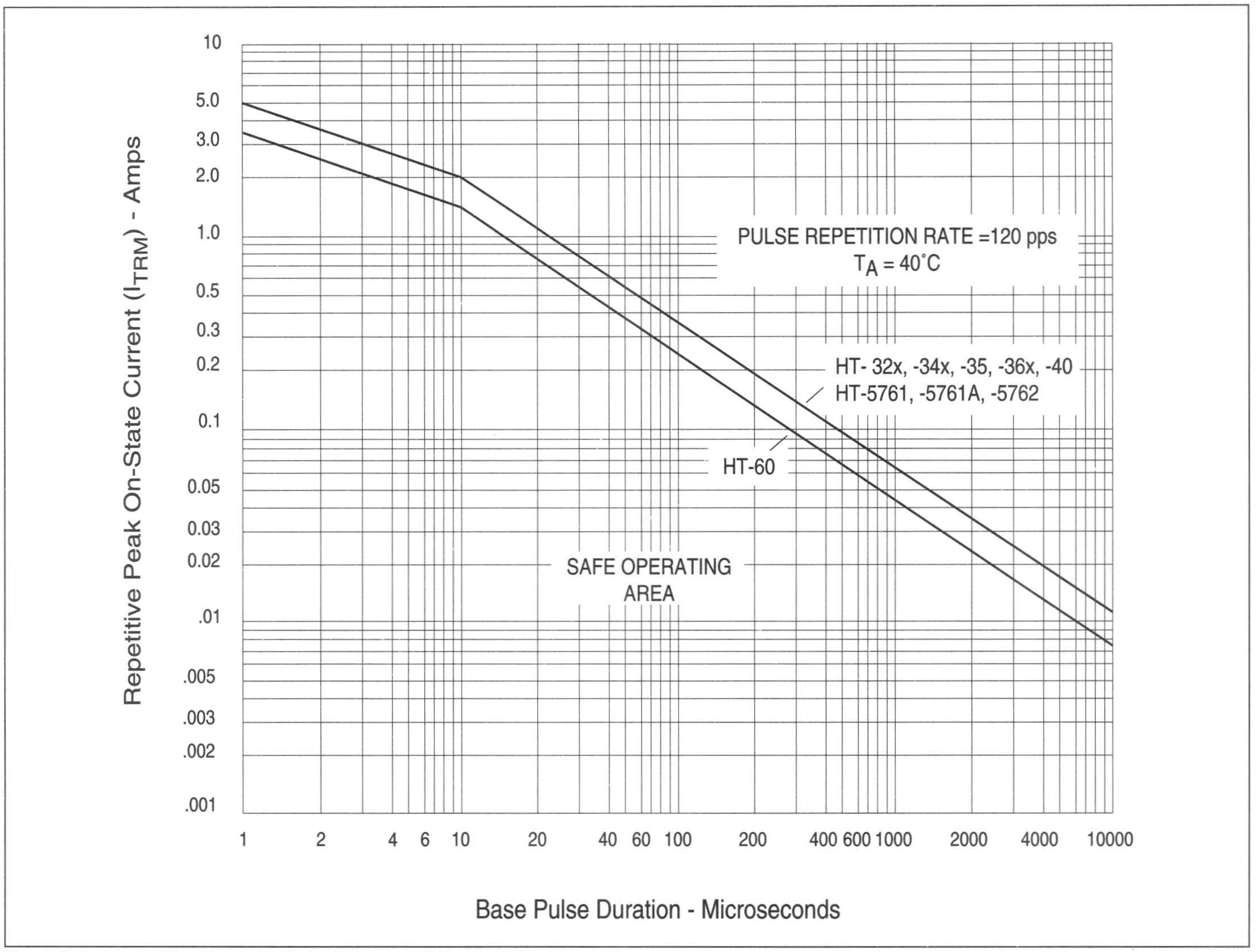


Figure 8.2 Repetitive Peak On-State Current vs Pulse Duration

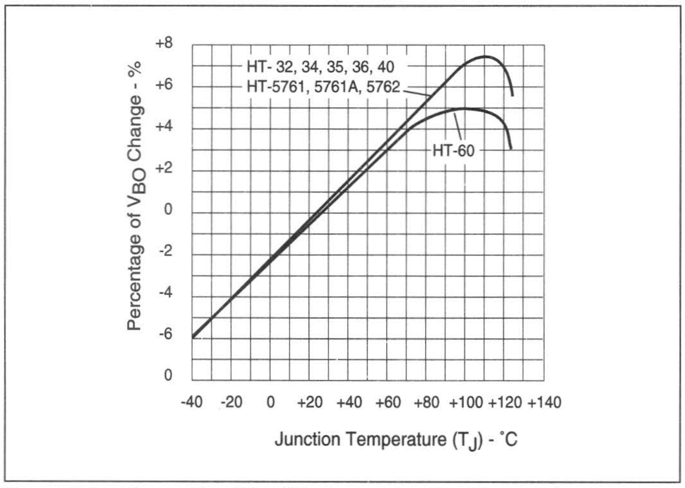


Figure 8.3 Normalized V_{BO} Change vs Junction Temperature

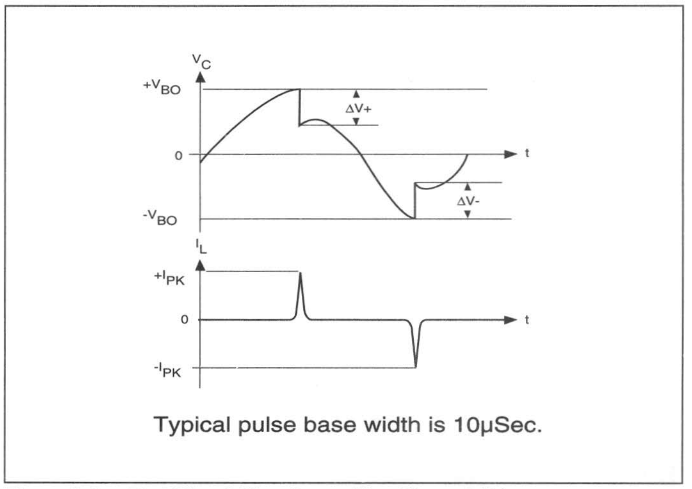


Figure 8.4 Test Circuit Waveforms (See Figure 8.5.)

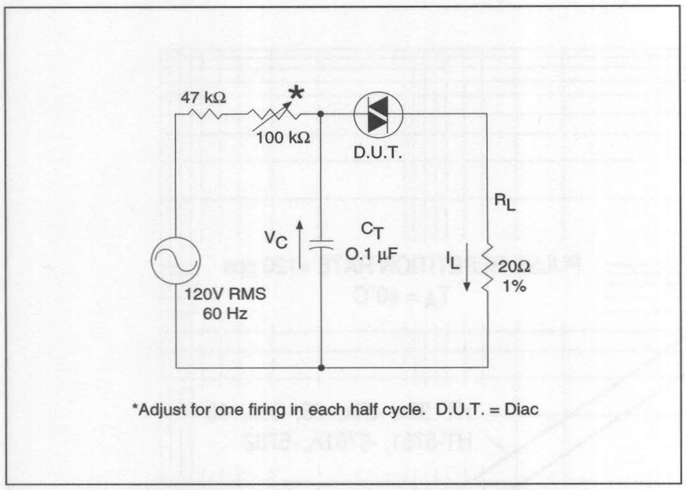


Figure 8.5 Circuit Used to Measure Diac Characteristics (See Figure 8.4.)

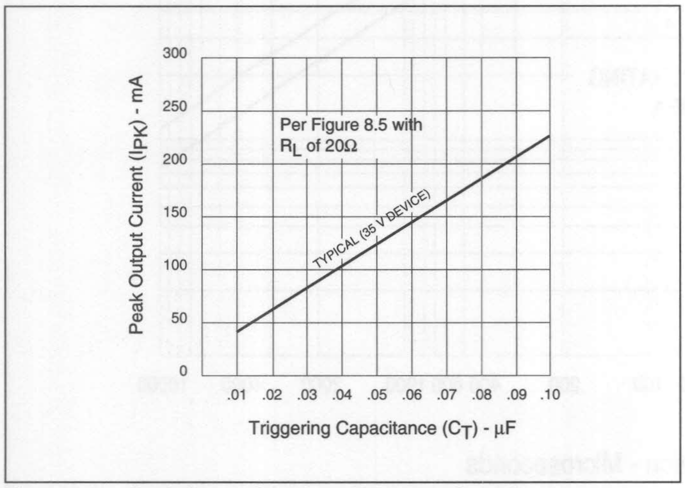


Figure 8.6 Peak Output Current vs Triggering Capacitance

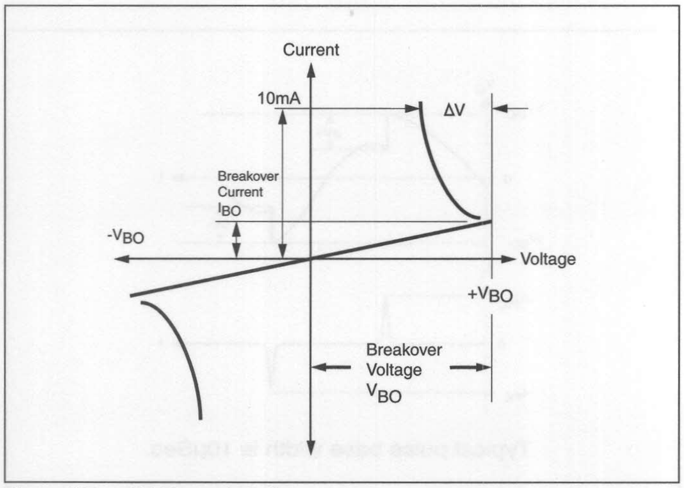
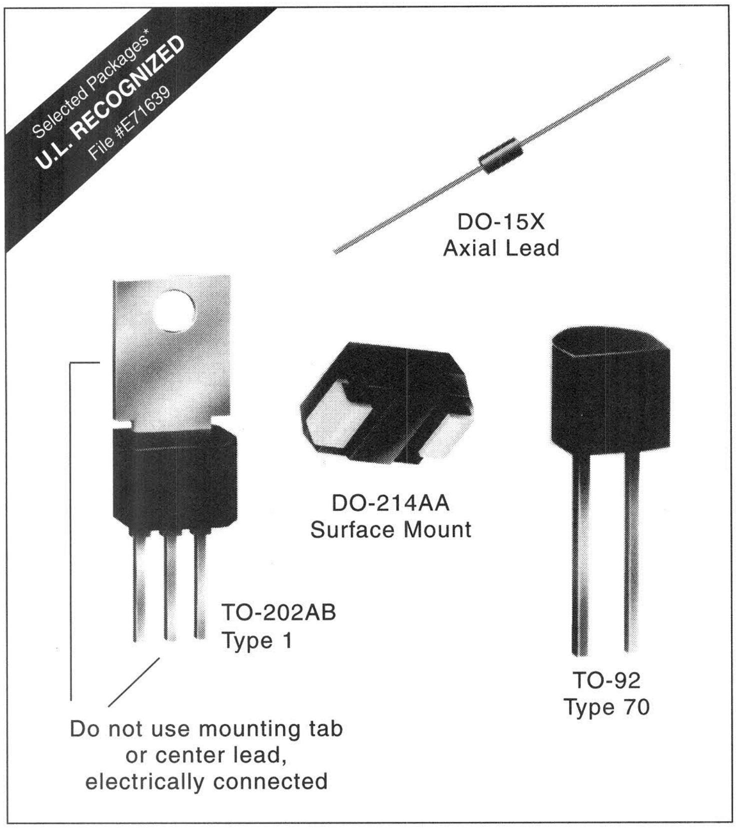
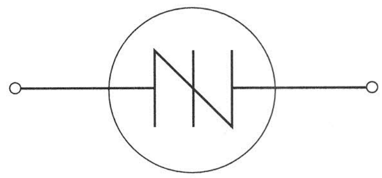


Figure 8.7 V-I Characteristics





SIDAC

(95 - 330 Volts)

General Description

The Sidac is a silicon bilateral voltage triggered switch with greater power-handling capabilities than standard diacs. Upon application of a voltage exceeding the Sidac breakover voltage point, the Sidac switches on through a negative resistance region to a low on-state voltage. Conduction will continue until the current is interrupted or drops below the minimum holding current of the device.

Teccor offers the complete voltage range (95-330) over three different packages:

- TO-92 (95-280 volts)
- Axial lead DO-15X (95-330 volts)
- Surface Mount DO-214AA (95-330 volts)
- TO-202AB (190-330 volts)

Teccor's Sidacs feature glass passivated junctions to ensure a rugged and dependable device capable of withstanding harsh environments.

Variations of devices covered in this data sheet are available for custom design applications. Please consult the factory for more information.

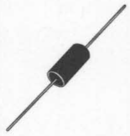
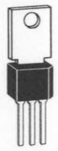
Applications

- **High voltage lamp ignitors**
- **Natural gas ignitors**
- **Gas oil ignitors**
- **High voltage power supplies**
- **Xenon ignitors**
- **Over voltage protector**
- **Pulse generators**
- **Fluorescent lighting ignitors**
- **HID lighting ignitors**

Features

- **AC circuit oriented**
- **Glass-passivated junctions**
- **High surge current capability**

Electrical Specifications

Type	Part No.				$I_{T(RMS)}$	V_{DRM}	V_{BO}		I_{DRM}	I_{BO}
	 TO-92 E Package	 DO-15X G Package	 TO-202AB F Package	 DO-214AA S Package	On-State RMS Current $T_J \leq 110°C$ 50/60Hz Sine Wave (7) (8)	Repetitive Peak Off-State Voltage	Breakover Voltage 50/60Hz Sine Wave (1)		Repetitive Peak Off-State Current 50/60Hz Sine Wave $V=V_{DRM}$	Breakover Current 50/60Hz Sine Wave
					Amps	Volts	Volts		µAmps	µAmps
	See "Package Dimensions" section for variations.				MAX	MIN	MIN	MAX	MAX	MAX
	K1050E70	K1050G		K1050S	1.0	±90	95	113	5	10
	K1100E70	K1100G		K1100S	1.0	±90	104	118	5	10
	K1200E70	K1200G		K1200S	1.0	±90	110	125	5	10
	K1300E70	K1300G		K1300S	1.0	±90	120	138	5	10
	K1400E70	K1400G		K1400S	1.0	±90	130	146	5	10
	K1500E70	K1500G		K1500S	1.0	±90	140	170	5	10
	K2000E70	K2000G	K2000F1	K2000S	1.0	±180	190	215	5	10
	K2200E70	K2200G	K2200F1	K2200S	1.0	±180	205	230	5	10
	K2400E70	K2400G	K2400F1	K2400S	1.0	±190	220	250	5	10
			K2401F1		(10)	±190	220	250	5	10
	K2500E70	K2500G	K2500F1	K2500S	1.0	±190	240	280	5	10
		K3000G	K3000F1	K3000S	1.0	±190	270	330	5	10

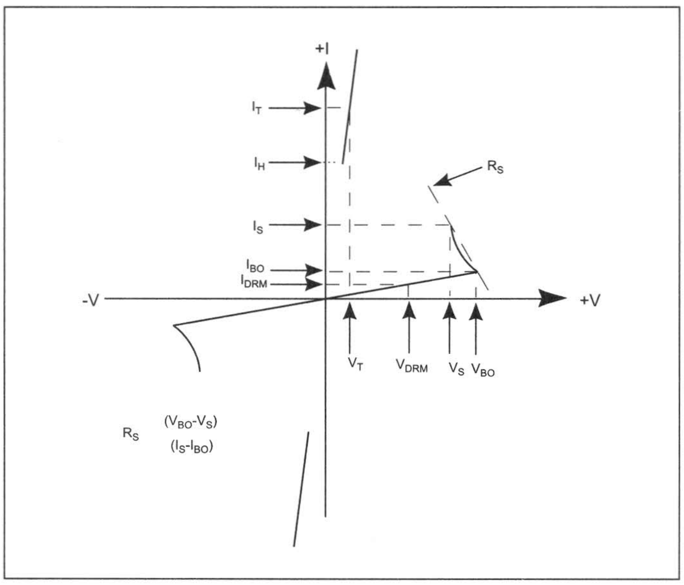
General Notes

- All measurements are made at 60Hz with a resistive load at an ambient temperature of +25°C unless otherwise specified.
- Storage temperature range (T_S) is -65°C to +150°C.
- The case (T_C) or lead (T_L) temperature is measured as shown on the dimensional outline drawings. See "Package Dimensions" section of this catalog.
- Junction temperature range (T_J) is -40°C to +110°C.
- Lead solder temperature is a maximum of +230°C for 10 seconds maximum; ≥ 1/16" (1.59mm) from case.

Electrical Specification Notes

(1) See Figure 9.6 for V_{BO} change vs junction temperature.
(2) See Figure 9.7 for I_{BO} vs junction temperature.
(3) See Figure 9.2 for I_H vs case temperature.
(4) See Figure 9.14 for test circuit.
(5) See Figure 9.1 for more than one full cycle rating.
(6) $R_{\theta JA}$ for TO-202 Type 23 and Type 41 is 70°C/watt.
(7) $T_C \leq 80°C$ for TO-92 Sidac and $T_C \leq 100°C$ for TO-202 Sidacs. $T_L \leq 85°C$ for DO-15X and $T_L \leq 75°C$ for DO-214AA.
(8) See Figure 9.15 for clarification of Sidac operation.
(9) For best Sidac operation, the load impedance should be near or less than switching resistance.
(10) Teccor's new, improved series of sidacs is designed to ensure good commutation at higher switching frequencies as required in ignitor circuits for high intensity discharge (HID) lighting. A typical circuit for a metal halide lamp ignitor is shown in the schematic, Figure 9.3. With proper component selection this circuit will produce three pulses for ignition of Osram lamp types such as HQI-T70W, HQI-T150W, and HQI-T250W which require a minimum of three pulses at 4kV magnitude and >1µs duration each at a minimum repetition rate of 3.3kHz.

I_H		V_{TM}				I_{TSM}		R_S	dV_q/dt	dv/dt	di/dt
Dynamic Holding Current 50/60Hz Sine Wave R = 100Ω (3) (4)		Peak On-State Voltage I_T = 1 Amp Volts Max				Peak One Cycle Surge Current 50/60Hz Sine Wave (Non-Repetitive) (5) Amps		Switching Resistance $R_S = \frac{(V_{BO}-V_S)}{(I_S-I_{BO})}$ 50/60Hz Sine Wave (9)	Critical Rate-of-Rise of Turn-off Voltage at 8kHz	Critical Rate-of-Rise of Off-State Voltage at Rated V_{DRM} $T_J \leq 100°C$	Critical Rate-of-Rise of On-State Current
		Package				60Hz	50Hz	kΩ	Volts/µSec	Volts/µSec	Amps/µSec
TYP	MAX	E	G	F	S			MIN	MIN	MIN	TYP
60	150	1.5	1.5		1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5		1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5		1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5		1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5		1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5		1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5	3.0	1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5	3.0	1.5	20	16.7	0.1	20	1500	150
60	150	1.5	1.5	3.0	1.5	20	16.7	0.1	20	1500	150
60	150			3.0		20	16.7	2.0	42	1500	150
60	150	1.5	1.5	3.0	1.5	20	16.7	0.1	20	1500	150
60	150		1.5	3.0	1.5	20	16.7	0.1	20	1500	150



V-I Characteristics

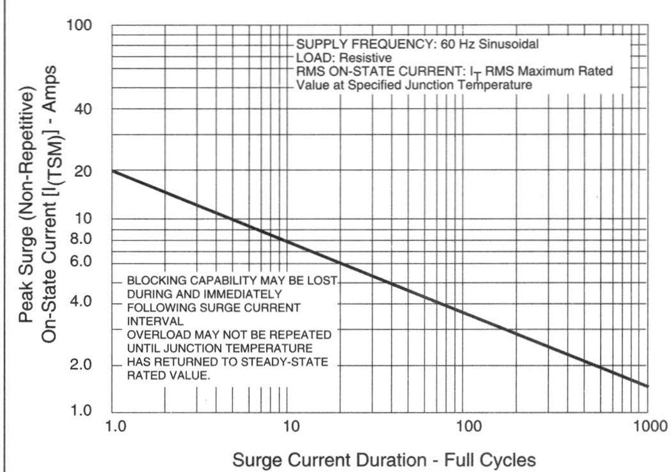
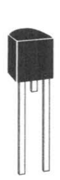


Figure 9.1 Peak Surge Current vs Surge Current Duration

THERMAL RESISTANCE (STEADY STATE) $R_{\theta JC}$ [$R_{\theta JA}$] °C/W (TYPICAL)			
 E	 G	 F (6)	 S
50 [105]	28 [79]	8 [45]	32 [90]

Electrical Specifications

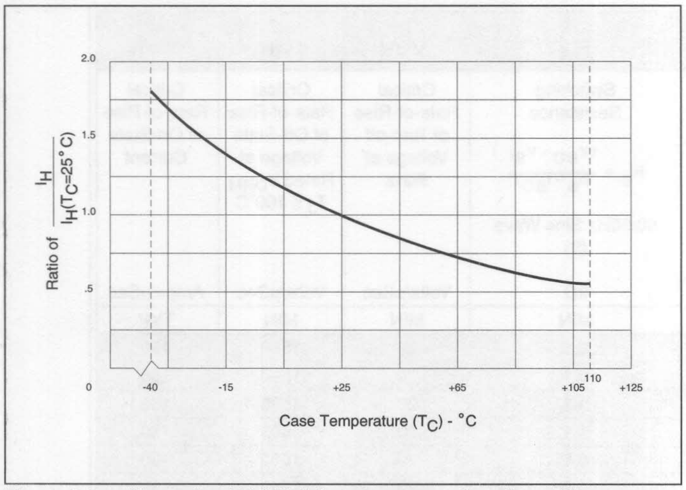


Figure 9.2 Normalized DC Holding Current vs Case/Lead Temperature

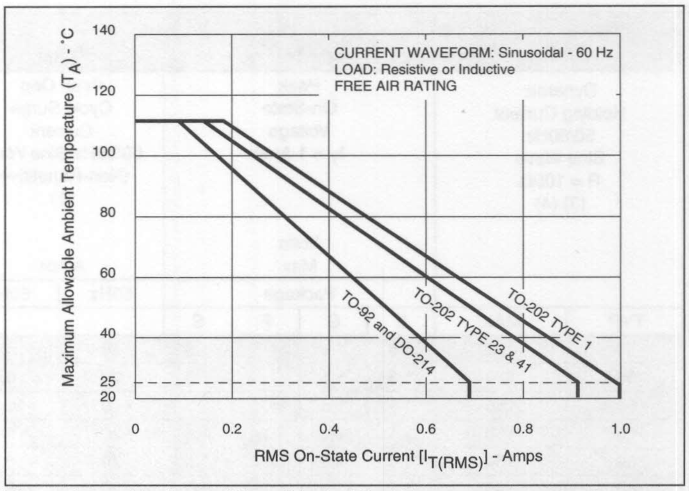


Figure 9.5 Maximum Allowable Ambient Temperature vs On-State Current

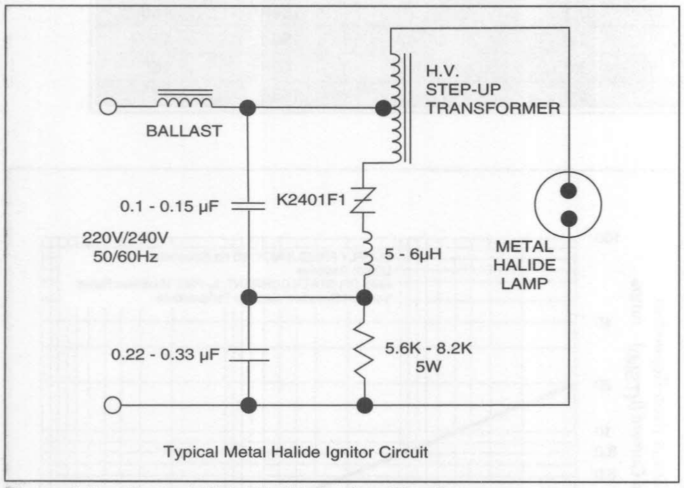


Figure 9.3 Typical Metal Halide Ignitor Circuit

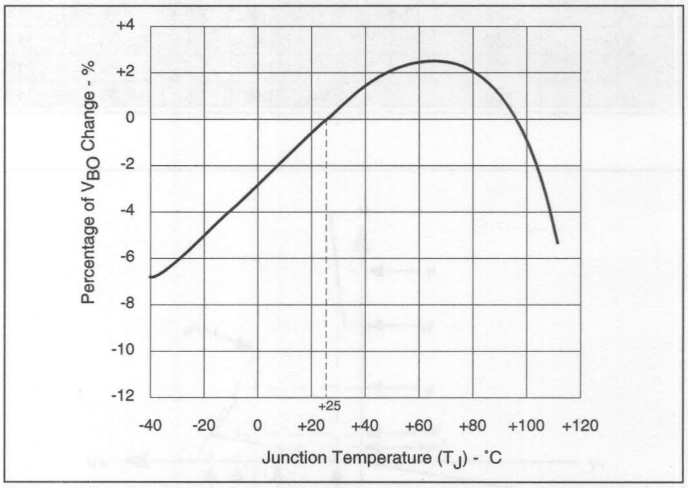


Figure 9.6 Normalized V_{BO} Change vs Junction Temperature

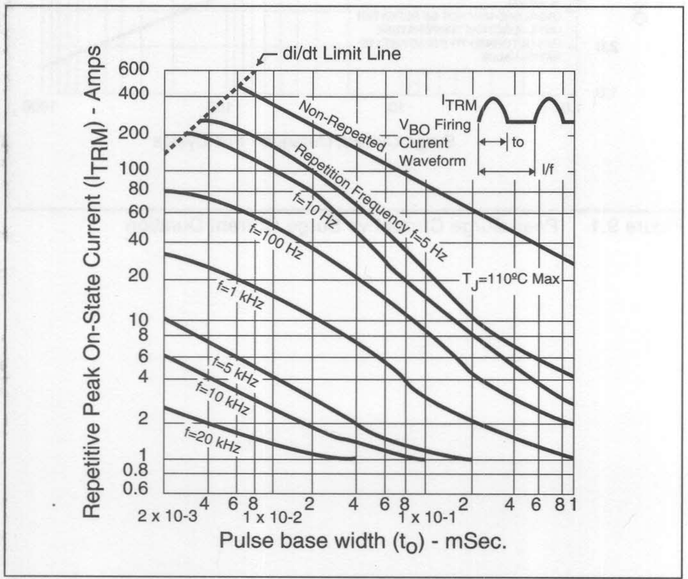


Figure 9.4 Repetitive Peak On-State Current (I_{TRM}) vs Pulse Width at Various Frequencies

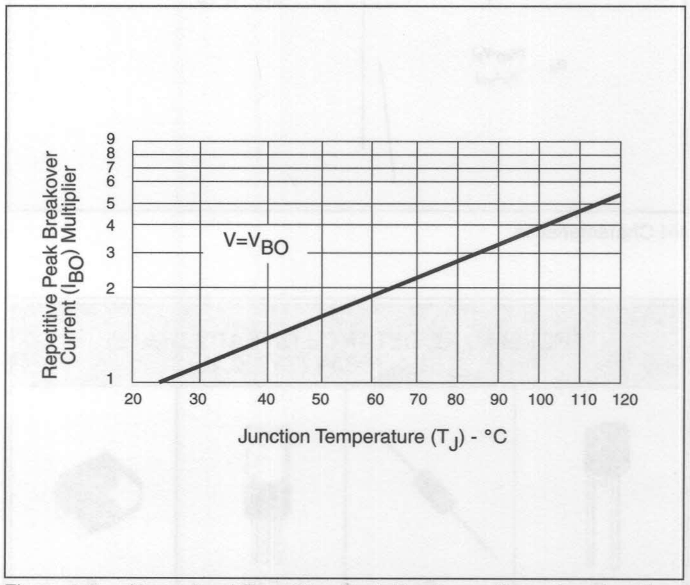


Figure 9.7 Normalized Repetitive Peak Breakover Current vs Junction Temperature

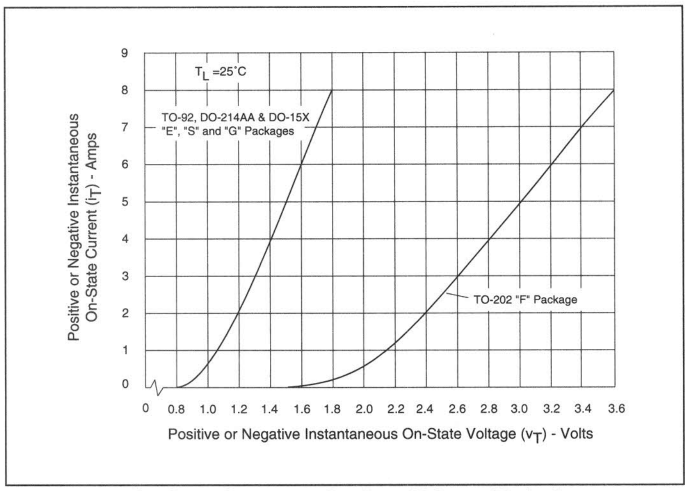


Figure 9.8 On-State Current vs On-State Voltage (Typical)

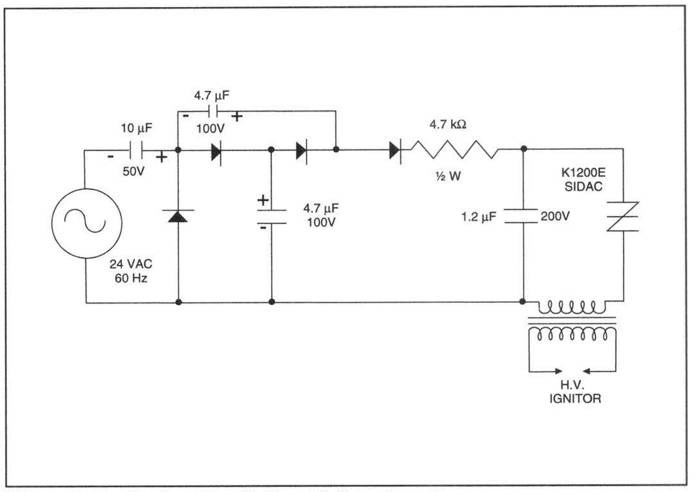


Figure 9.11 Ignitor Circuit (Low Voltage Input)

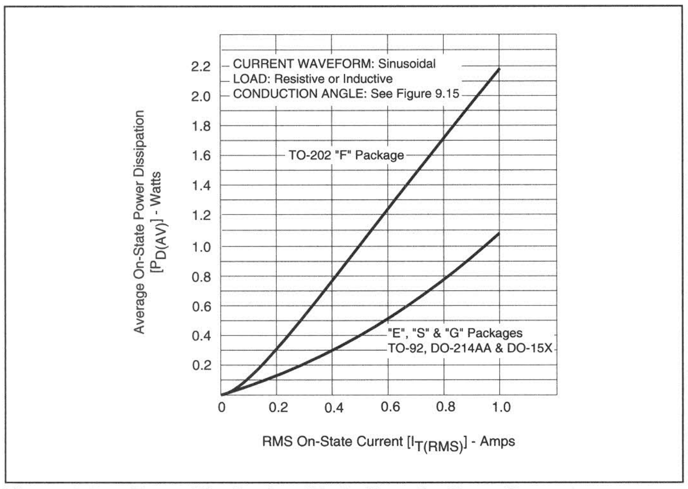


Figure 9.9 Power Dissipation (Typical) vs On-State Current

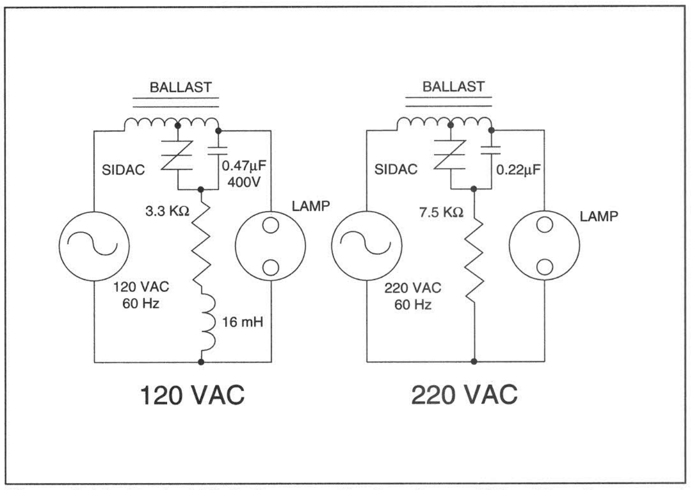


Figure 9.12 Typical High Pressure Sodium Lamp Firing Circuit

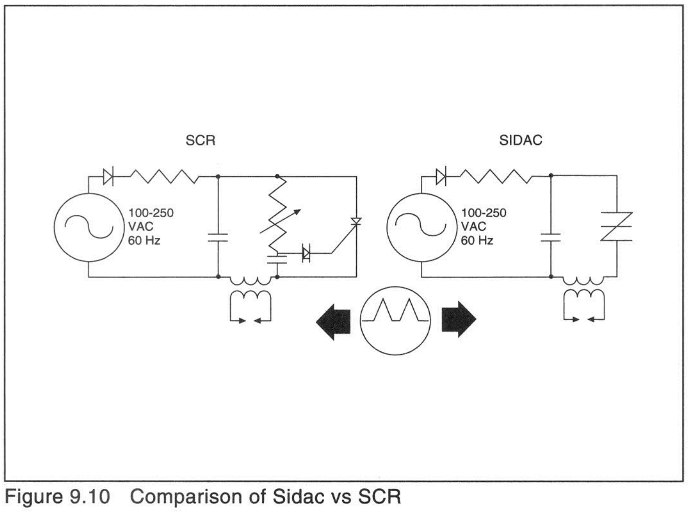


Figure 9.10 Comparison of Sidac vs SCR

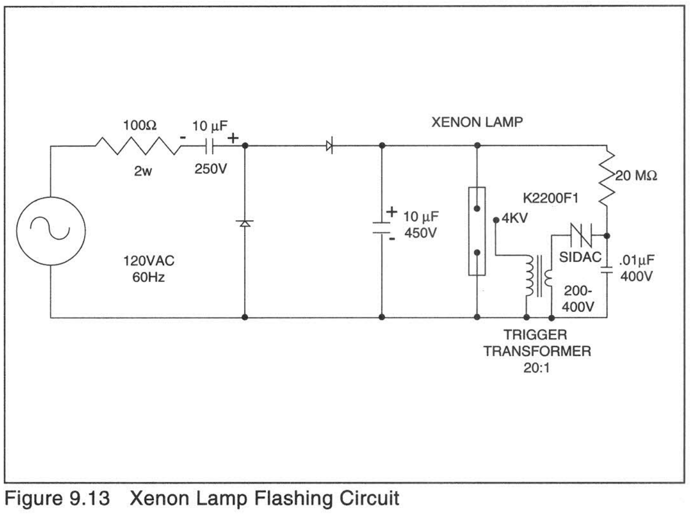


Figure 9.13 Xenon Lamp Flashing Circuit

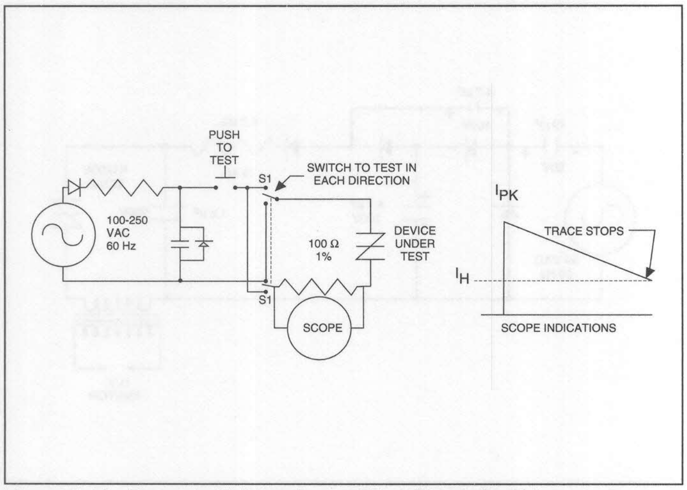


Figure 9.14 Dynamic Holding Current Test Circuit for Sidacs

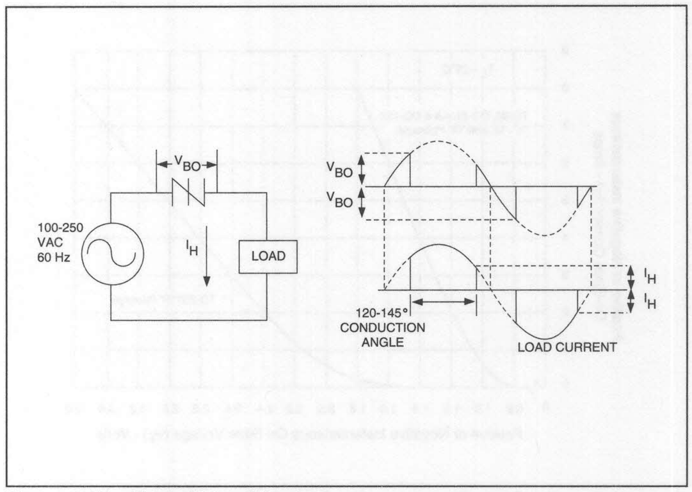


Figure 9.15 Basic Sidac Circuit

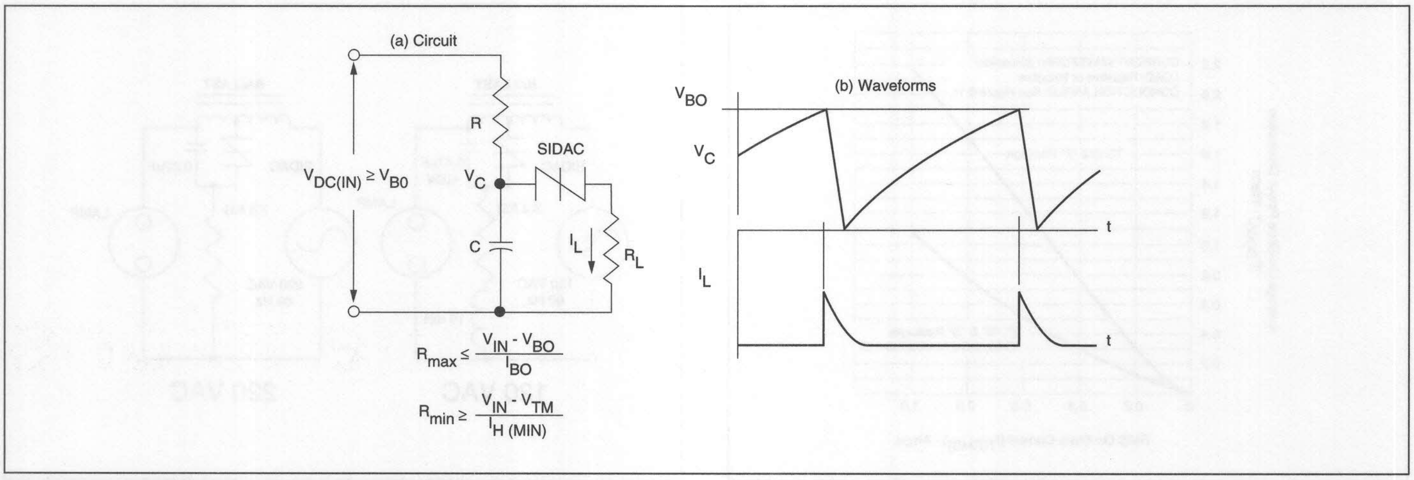
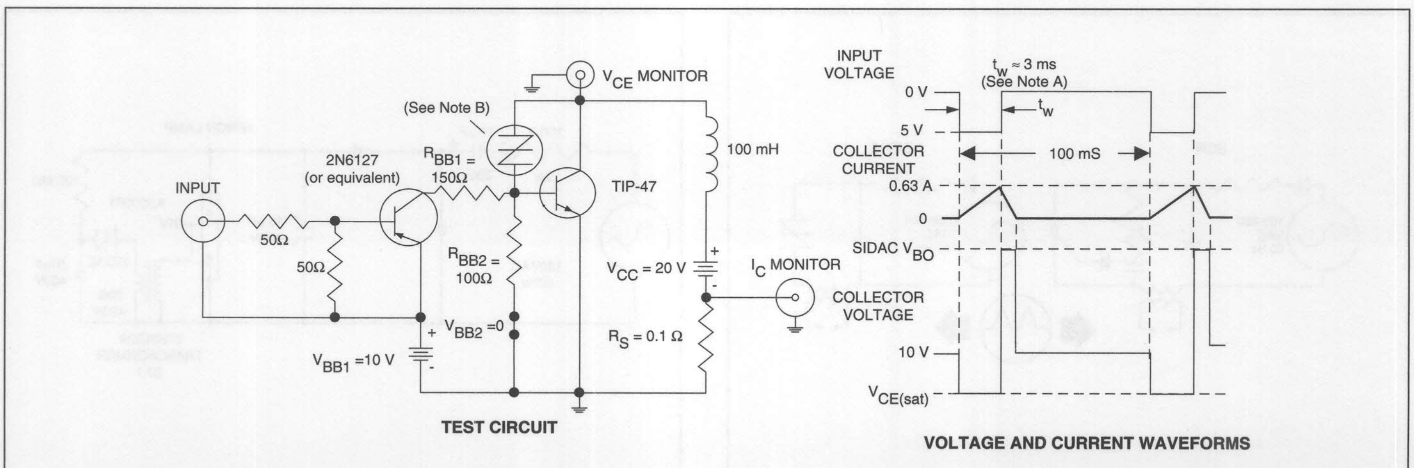


Figure 9.16 Relaxation oscillator Using a Sidac



NOTE A: Input pulse width is increased until I_{CM} = 0.63A.

NOTE B: Sidac (or Diac or series of Diacs) chosen so that V_{BO} is just below V_{CEO} rating of transistor to be protected. The Sidac (or Diac) eliminates a reverse breakdown of the transistor in inductive switching circuits where otherwise the transistor could be destroyed.

Figure 9.17 Sidac Added to Protect Transistor for Typical Transistor Inductive Load Switching Requirements

Package Dimensions

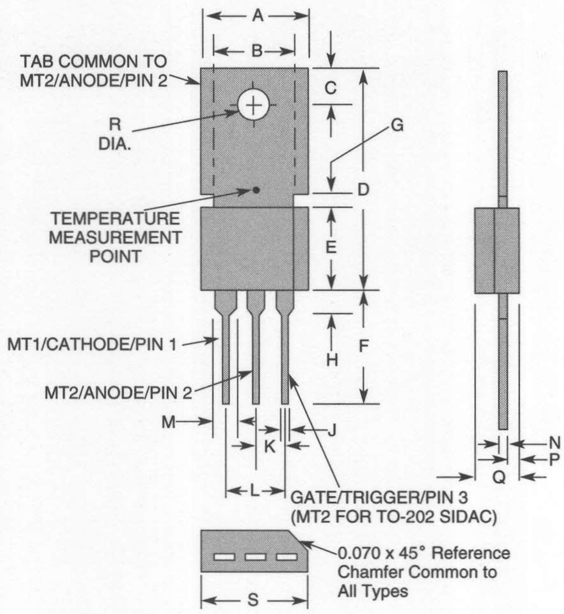
This section contains the dimensions for the following packages:

- "F" Package—TO-202AB, Type 1 (Non-Isolated)
- "Y" Package—DO-35 or DO-204AH
- "R" Package—TO-220AB THERMOTAB (Non-Isolated)
- "L" Package—TO-220AB THERMOTAB (Isolated)
- "P" Package—TO-3 FASTPAK (Isolated)
- "E" Package—TO-92 (Isolated)
- "S" Package—DO-214AA
- "M" Package—TO-218AC (Non-Isolated)
- "K" Package—TO-218AC (Isolated)
- "W" Package—TO-218X (Non-Isolated)
- "J" Package—TO-218X (Isolated)
- "G" Package—DO-15X Axial Lead

Note: Due to manufacturing tolerances and methods small amounts of flash may appear on any molded part. In some instances this flash may break off later in the manufacturing process and expose bare copper. In other cases there may be bare copper showing after cutting or trimming parts. This does not affect the electrical operation of these parts. With proper soldering techniques any bare copper can easily be soldered.

Package Dimensions

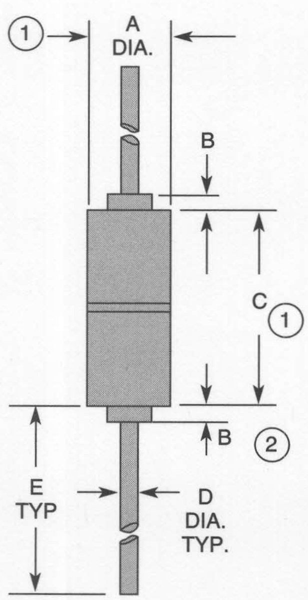
"F" Package (Non-Isolated Mounting Tab—common to MT2/Anode/Pin2)
TO-202AB, Type 1



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.365	.385	9.27	9.78
B	.243	.253	6.17	6.43
C	.110	.120	2.79	3.05
D	.780	.810	19.81	20.57
E	.290	.310	7.37	7.87
F	.400	.430	10.16	10.92
G	.052	.062	1.32	1.58
H	.055	.065	1.40	1.65
J	.023	.029	0.58	0.74
K	.095	.105	2.41	2.67
L	.195	.205	4.95	5.21
M	.049	.059	1.24	1.50
N	.017	.023	.43	.58
P	.055	.065	1.40	1.65
Q	.175	.185	4.45	4.70
R	.124	.130	3.15	3.30
S	.390	.405	9.91	10.29

NOTES:
(1) Maximum torque to be applied to mounting tab is 8 in-lbs. (0.904 Nm)
(2) Pin 2 and mounting tab are electrically connected. Do not use either for Sidac operation.

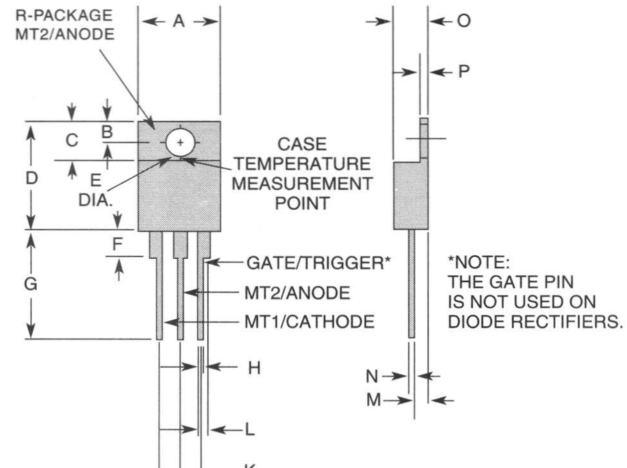
"Y" Package
DO-35 or DO-204AH



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.06	.09	1.53	2.28
B		.015		0.381
C	.135	.165	3.43	4.19
D	.018	.022	0.458	0.558
E	1.0		25.4	

(1) Package contour optional within dimensions A and C. Slugs, if any, shall be included within this cylinder but shall not be subject to the minimum limit of Dim. A.
(2) Lead diameter not controlled in this zone to allow for flash, lead finish build-up, and minor irregularities other than slugs.

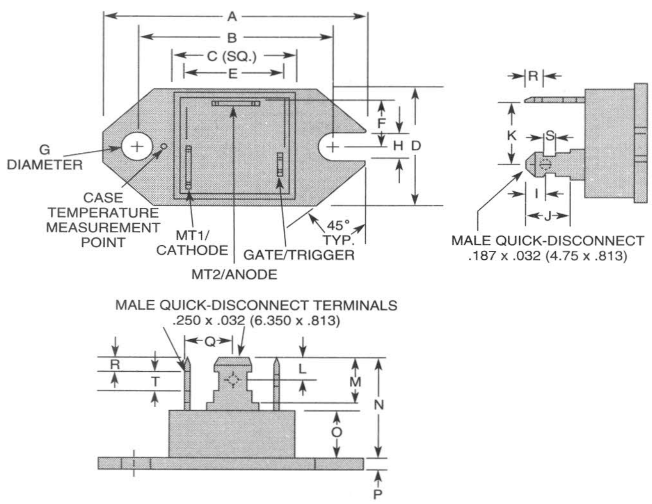
"R" Package (Non-Isolated Mounting Tab—center lead and tab common)
"L" Package (Isolated Mounting Tab)
TO-220AB THERMOTAB



NOTE: Maximum torque to be applied to mounting tab is 8 in-lbs. (0.904 Nm)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.380	.420	9.65	10.67
B	.105	.115	2.66	2.92
C	.230	.250	5.85	6.35
D	.590	.620	14.98	15.75
E	.142	.147	3.61	3.73
F	.110	.130	2.80	3.30
G	.540	.575	13.71	14.60
H	.025	.035	0.63	0.89
J	.195	.205	4.95	5.21
K	.095	.105	2.41	2.67
L	.060	.075	1.52	1.91
M	.070	.085	1.78	2.16
N	.018	.024	0.45	0.61
O	.178	.188	4.52	4.78
P	.045	.060	1.14	1.53

"P" Package (Isolated Mounting Base)
TO-3 FASTPAK

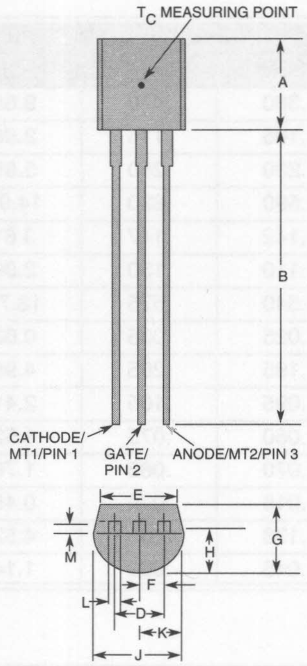


DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.500	1.550	38.10	39.37
B	1.177	1.197	29.895	30.404
C	0.737	0.757	18.72	19.228
D	0.755	0.770	19.177	19.558
E	0.565	0.595	14.351	15.113
F	0.260	0.320	6.604	8.128
G	0.151	0.161	3.835	4.089
H	0.151	0.161	3.835	4.089
I	0.092	0.106	2.336	2.692
J	0.245	0.255	6.223	6.477
K	0.395	0.425	10.033	10.795
L	0.144	0.160	3.657	4.064
M	0.307	0.317	7.797	8.052
N	0.640	0.690	16.256	17.526
O	0.270	0.310	6.858	7.874
P	0.091	0.098	2.311	2.489
Q	0.282	0.298	7.162	7.569
R	0.095	0.105	2.413	2.667
S	0.095	0.105	2.41	2.67
T	0.125	0.135	3.175	3.429

Note: Maximum torque to be applied to mounting tab is 8 in-lbs. (0.904 Nm)

Package Dimensions

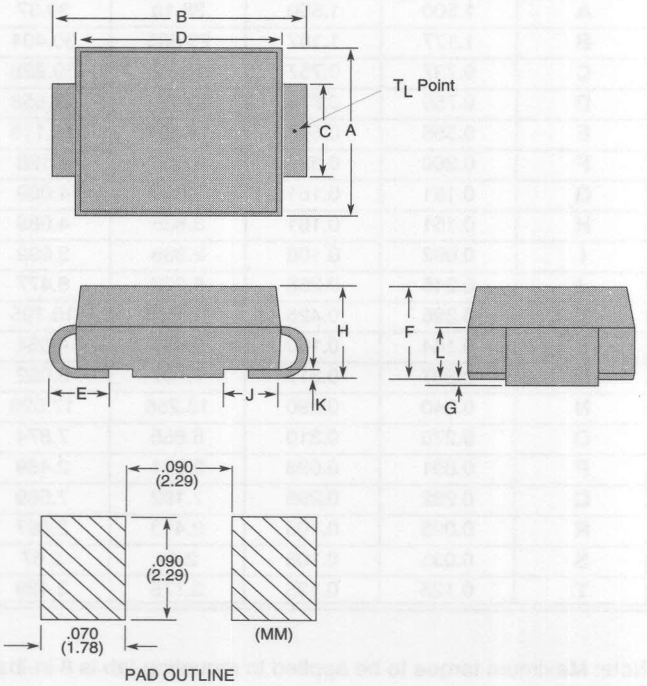
"E" Package
TO-92



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.176	.196	4.47	4.98
B	.500		12.70	
D	.095	.105	2.41	2.67
E	.150		3.81	
F	.046	.054	1.16	1.37
G	.135	.145	3.43	3.68
H	.088	.096	2.23	2.44
J	.176	.186	4.47	4.73
K	.088	.096	2.23	2.44
L	.013	.019	0.33	0.48
M	.013	.017	0.33	0.43

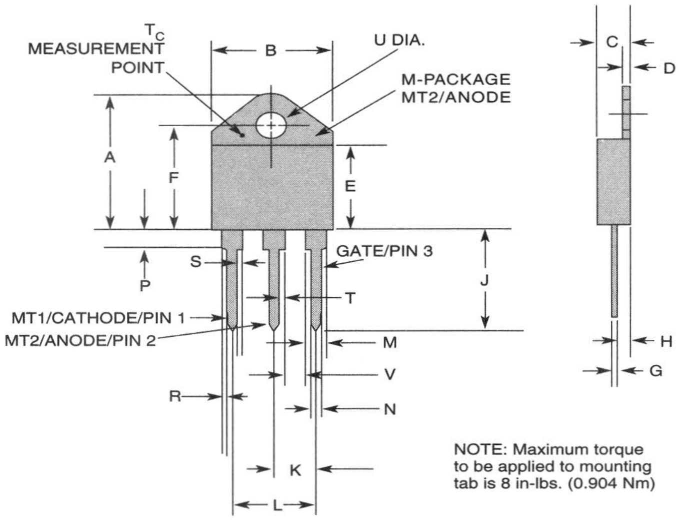
All leads insulated from case. Case is electrically nonconductive.

"S" Package
DO-214AA



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.140	.155	3.56	3.94
B	.205	.220	5.21	5.59
C	.077	.083	1.96	2.11
D	.166	.180	4.22	4.57
E	.036	.056	.91	1.42
F	.073	.083	1.85	2.11
G	.004	.008	.10	.20
H	.082	.092	2.08	2.34
J	.043	.053	1.09	1.35
K	.008	.012	.20	.30
L	.039	.049	.99	1.24

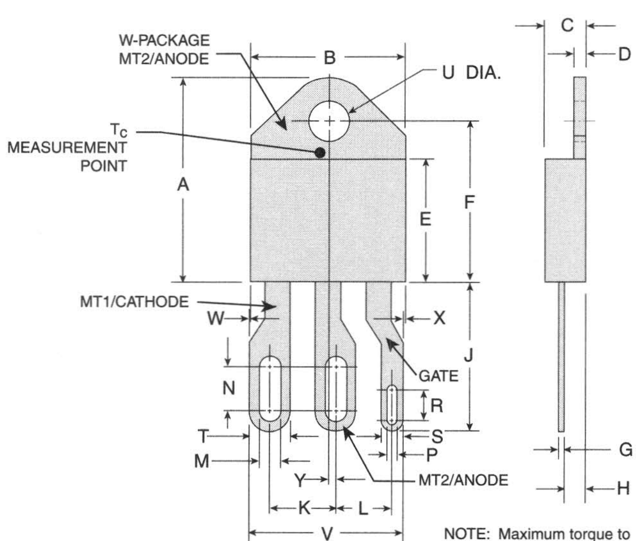
"M" Package (Non-Isolated Mounting Tab—center lead and tab common)
"K" Package (Isolated Mounting Tab)
TO-218AC



NOTE: Maximum torque to be applied to mounting tab is 8 in-lbs. (0.904 Nm)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.810	.835	20.57	21.21
B	.610	.630	15.49	16.00
C	.178	.188	4.52	4.78
D	.055	.070	1.40	1.78
E	.487	.497	12.37	12.62
F	.635	.655	16.13	16.64
G	.022	.029	0.56	0.74
H	.075	.095	1.91	2.41
J	.575	.625	14.61	15.88
K	.211	.219	5.36	5.56
L	.422	.437	10.72	11.10
M	.100	.110	2.54	2.79
N	.045	.055	1.14	1.40
P	.095	.115	2.41	2.92
R	.008	.016	0.20	0.41
S	.038	.048	0.97	1.22
T	.025	.032	0.64	0.81
U	.159	.163	4.04	4.14
V	.090	.100	2.29	2.54

"W" Package (Non-Isolated Mounting Tab—center lead and tab common)
"J" Package (Isolated Mounting Tab)
TO-218X

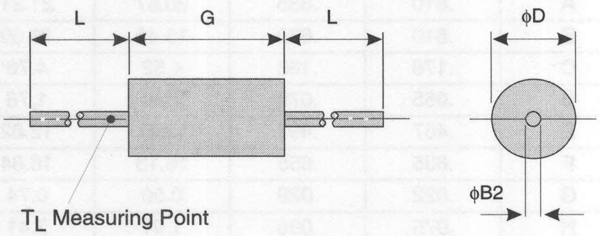


NOTE: Maximum torque to be applied to mounting tab is 8 in-lbs. (0.904 Nm)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.810	.835	20.57	21.21
B	.610	.630	15.49	16.00
C	.178	.188	4.52	4.78
D	.055	.070	1.40	1.78
E	.487	.497	12.37	12.62
F	.635	.655	16.13	16.64
G	.022	.029	0.56	0.74
H	.075	.095	1.91	2.41
J	.575	.625	14.61	15.88
K	.256	.264	6.50	6.71
L	.220	.228	5.58	5.79
M	.080	.088	2.03	2.24
N	.169	.177	4.29	4.49
P	.034	.042	0.86	1.07
R	.113	.121	2.87	3.07
S	.086	.096	2.18	2.44
T	.156	.166	3.96	4.22
U	.159	.163	4.04	4.14
V	.603	.618	15.31	15.70
W	.000	.005	0.00	.13
X	.003	.012	.07	.30
Y	.028	.032	.71	.81

Package Dimensions

"G" Package
DO-15X
Axial Lead



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
ϕB2	.027	.035	.686	.889
ϕD	.104	.150	2.64	3.81
G	.230	.300	5.84	7.62
L	1.00		25.4	

Lead Form Dimensions

The TO-202AB, TO-220AB and TO-92 package configurations, because of their unique design, are capable of being mounted in a variety of methods ... depending upon heatsink requirements and circuit packaging methods. Any of the derived types shown in the following charts are available as standard parts direct from the factory. Other package variations are available on a "Special Basis." Contact the factory for special variations.

To designate lead form options, simply indicate the "Type Number" at the end of the Teccor standard part number. See part number definition.

EXAMPLE: Q2004F3<u>12</u> (Signifies Type 12)

Note: If you are ordering a TO-202 "F" package you must include a "1" for standard full tab package. If you want anything other than full tab, remove the "1" and add the Lead Form Type.

Lead Bending Specifications

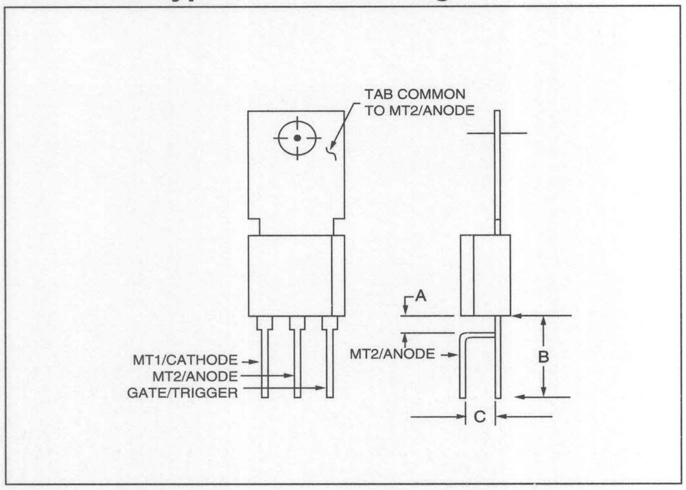
Leads may be easily bent, and may be bent to any desired angle, provided that the bend is made at a minimum .063" (0.1 for TO-218) away from the package body with a minimum radius of .032". Leads should be held firmly between the package body and the bend, so that strain on the leads is not transmitted to the package body.

When bending leads in the plane of the leads (spreading), bend only the narrow part.

Sharp angle bends should be done only once, as repetitive bending will fatigue and break the leads.

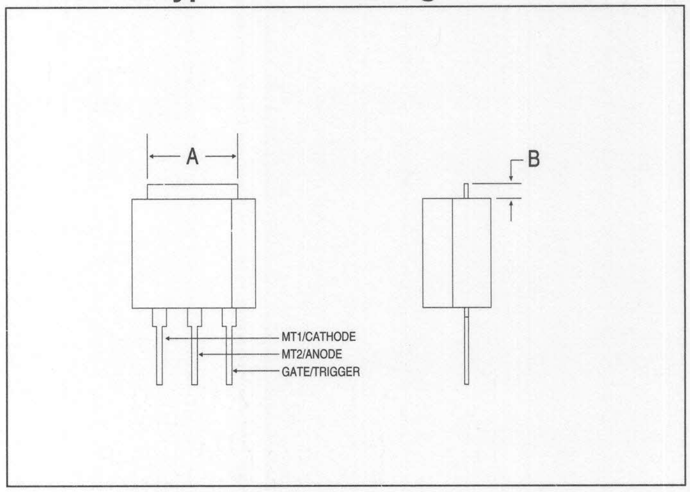
Lead Form Dimensions

TO-202AB Type 11—"F" Package



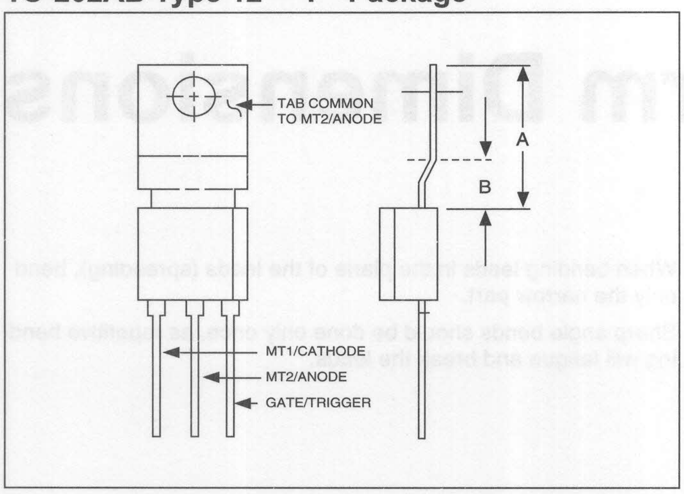
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.080	.120	2.03	3.05
B	.301	.361	7.65	9.17
C	.080	.120	2.03	3.05

TO-202AB Type 2—"F" Package



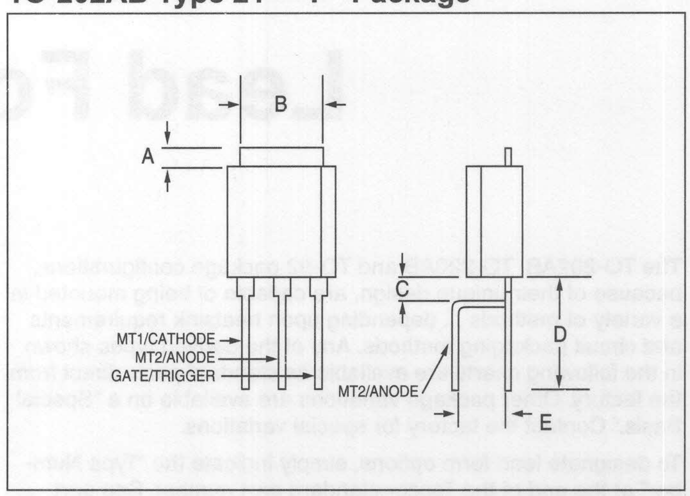
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.240	.260	6.10	6.60
B	.030	.050	.762	1.27

TO-202AB Type 12—"F" Package



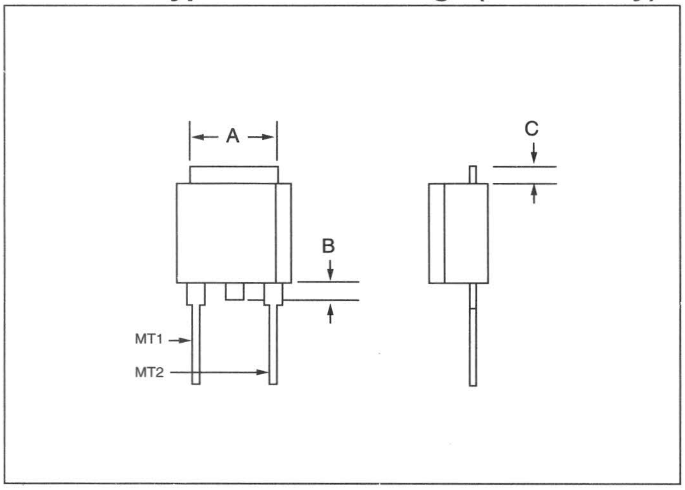
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.435	.495	11.05	12.57
B	.120	.160	3.05	4.06

TO-202AB Type 21—"F" Package



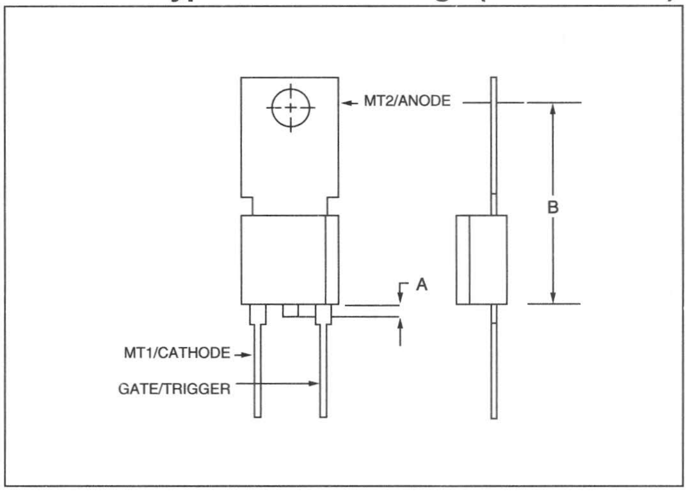
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.030	.050	.762	1.27
B	.240	.260	6.10	6.60
C	.080	.120	2.03	3.05
D	.301	.361	7.65	9.17
E	.080	.120	2.03	3.05

TO-202AB Type 23—"F" Package (SIDAC Only)



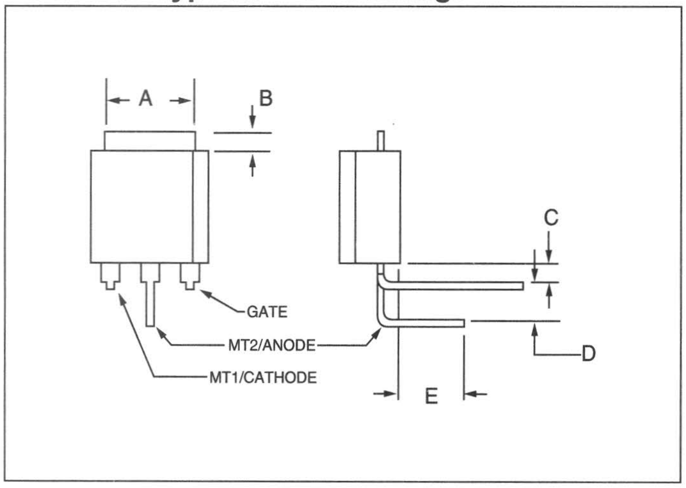
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.240	.260	6.10	6.60
B	.030	.050	.762	1.27
C	.030	.050	.762	1.27

TO-202AB Type 3 — "F" Package (Non-Isolated)



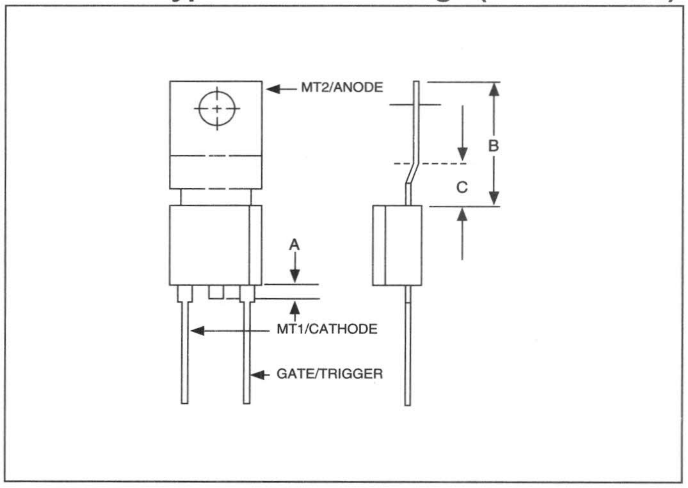
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.030	.050	.762	1.27
B	.645	.705	16.38	17.91

TO-202AB Type 26—"F" Package



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.240	.260	6.10	6.60
B	.030	.050	.762	1.27
C	.050	.070	.127	1.78
D	.095	.105	2.41	2.67
E	.172	.202	4.37	5.13

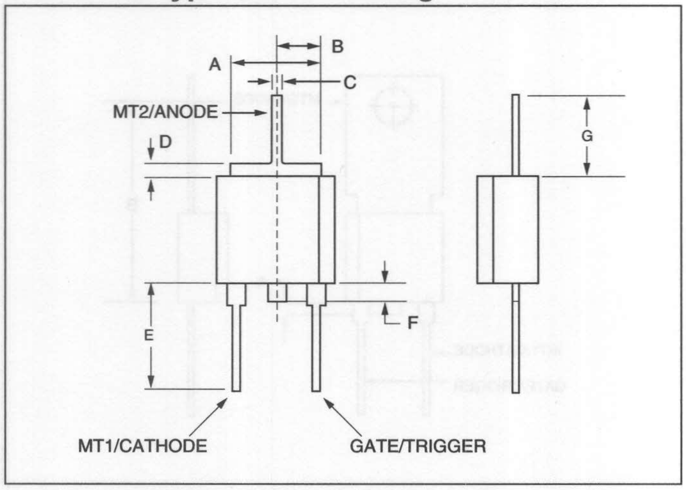
TO-202AB Type 32—"F" Package (Non-Isolated)



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.240	.260	6.10	6.60
B	.030	.050	.762	1.27
C	.030	.050	.762	1.27

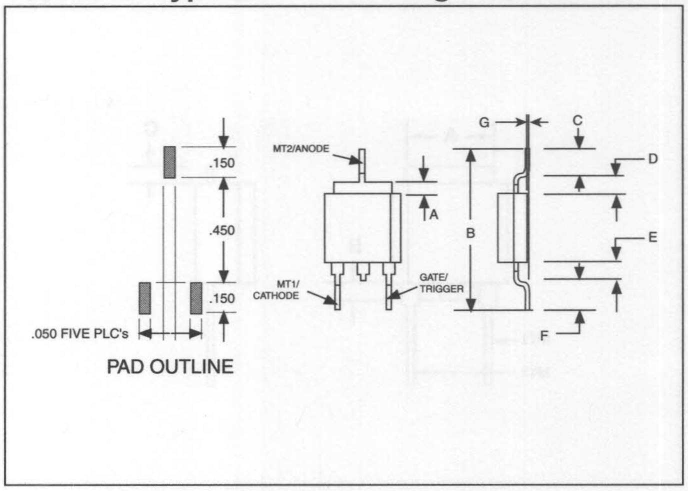
Lead Form Dimensions

TO-202AB Type 4—"F" Package



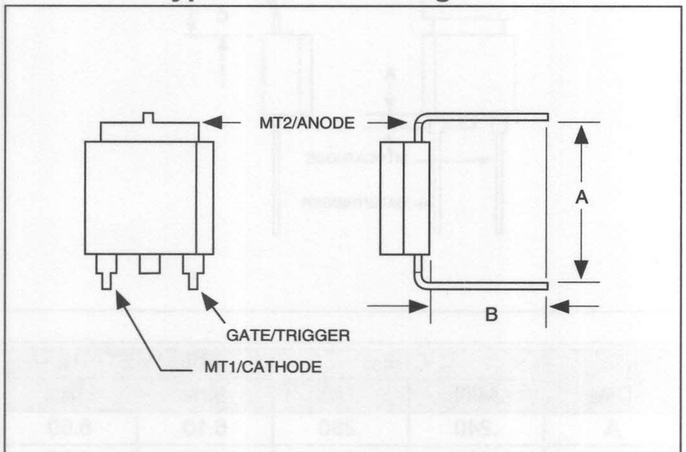
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.240	.260	6.10	6.60
B	.114	.134	2.90	3.40
C	.023	.029	.584	.737
D	.030	.050	.762	1.27
E	.297	.327	7.54	8.31
F	.030	.050	.765	1.27
G	.297	.327	7.54	8.31

TO-202AB Type 43—"F" Package Surface Mount



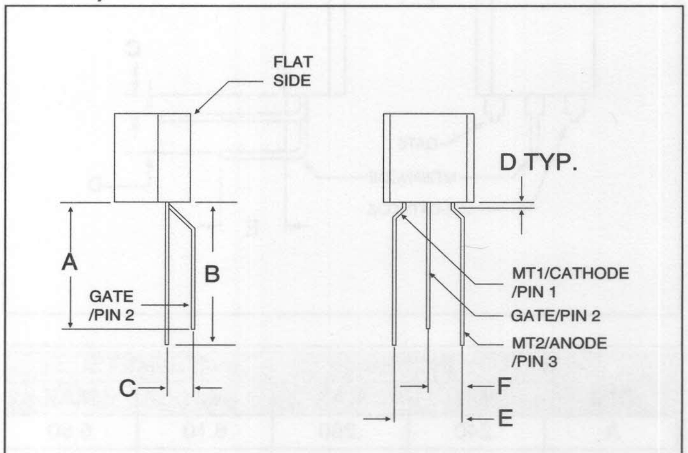
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.030	.050	.762	1.27
B	.680	.760	17.27	19.30
C	.110	.130	2.80	3.30
D	.080	.100	2.03	2.54
E	.080	.100	2.03	2.54
F	.110	.130	2.80	3.30
G	.000	.013	.000	.330

TO-202AB Type 41—"F" Package



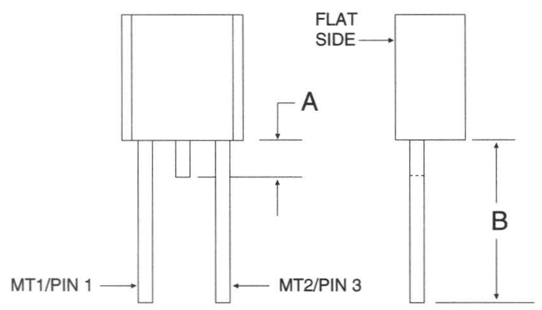
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.380	.420	9.65	10.67
B	.180	.220	4.57	5.59

TO-92 Type 75—"E" Package (Replaces TO-5 Pinout)



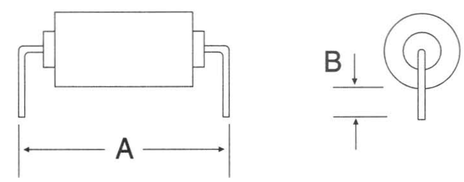
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.40		10.16	
B	.50		12.70	
C	.080	.120	2.03	3.05
D	.045	.085	1.14	2.16
E	.180	.220	4.57	5.59
F	.080	.120	2.03	3.05

TO-92 Type 70— "E" Package (For SIDAC Only)



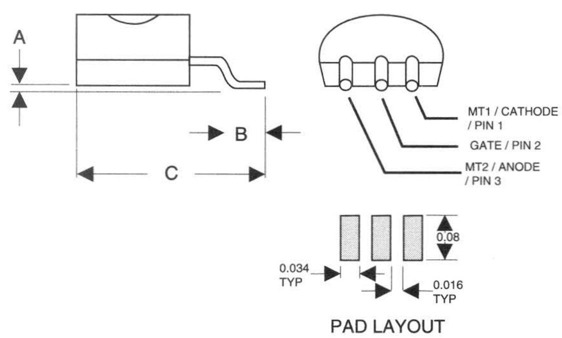
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A		.060		1.52
B	.50		12.7	

DO-35 Type 91—DO-35 Package



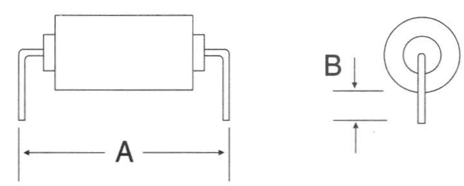
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.519	.521	12.18	13.23
B	.140	.172	3.56	4.37

TO-92 Type 73—"E" Package Surface Mount



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.000	.010	.000	.254
B	.052	.067	1.32	1.70
C	.295	.315	7.49	8.00

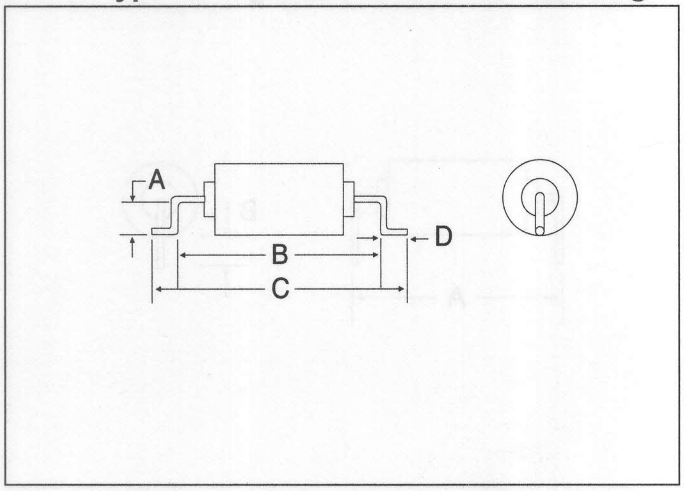
DO-35 Type 92—DO-35 Package



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.610	.630	15.49	16.00
B	.140	.172	3.56	4.37

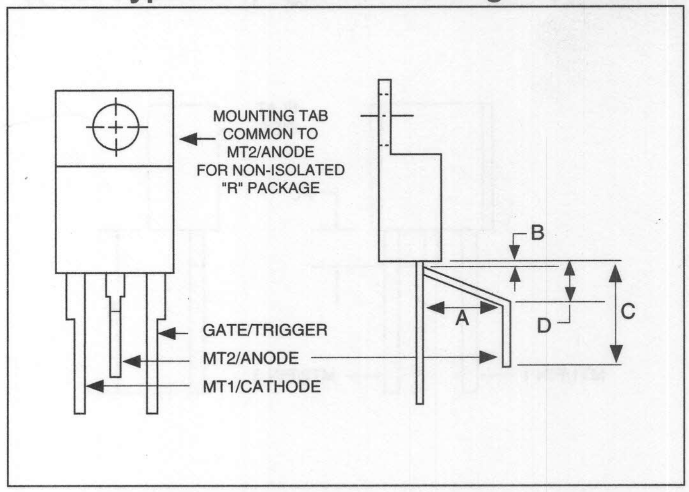
Lead Form Dimensions

DO-35 Type 93—Surface Mount DO-35 Package



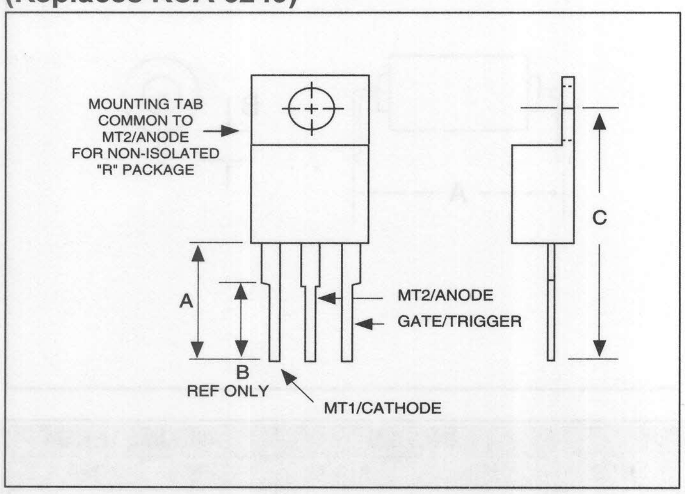
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.02	.06	.508	1.52
B	.290	.310	7.37	7.87
C	.370	.430	9.40	10.92
D	.040	.060	1.02	1.52

TO-220 Type 52—"R" or "L" Package



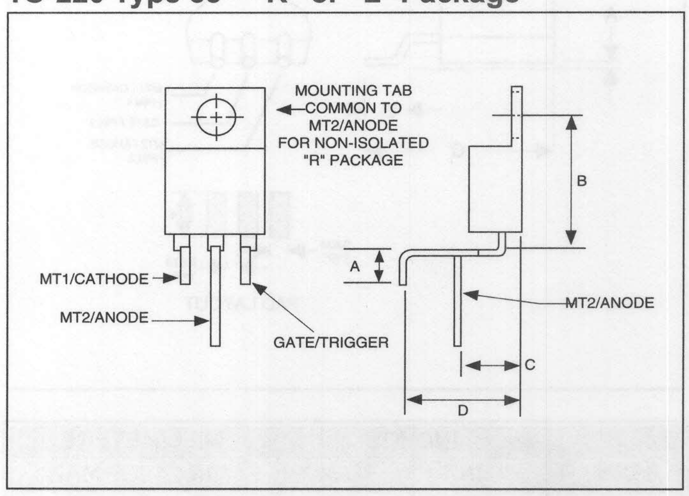
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.169	.189	4.29	4.80
B	.040	.060	1.02	1.52
C	.250		6.35	
D	.110	.170	2.79	4.32

TO-220 Type 51—"R" or "L" Package (Replaces RCA 6249)



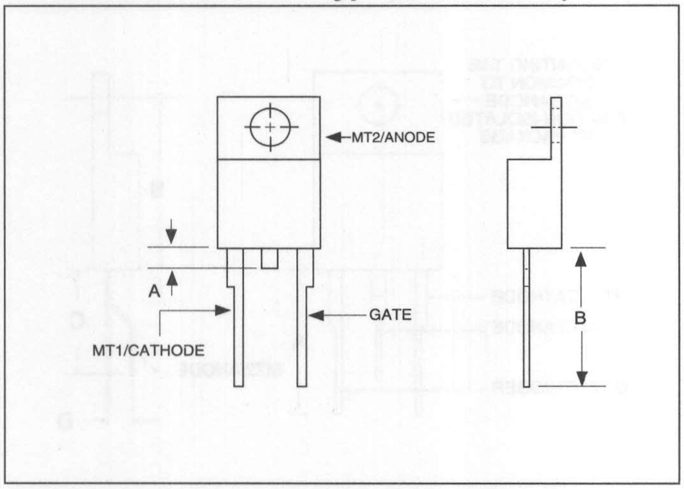
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.320	.340	8.13	8.64
B	.190		4.83	
C	.795	.850	20.19	21.59

TO-220 Type 53—"R" or "L" Package



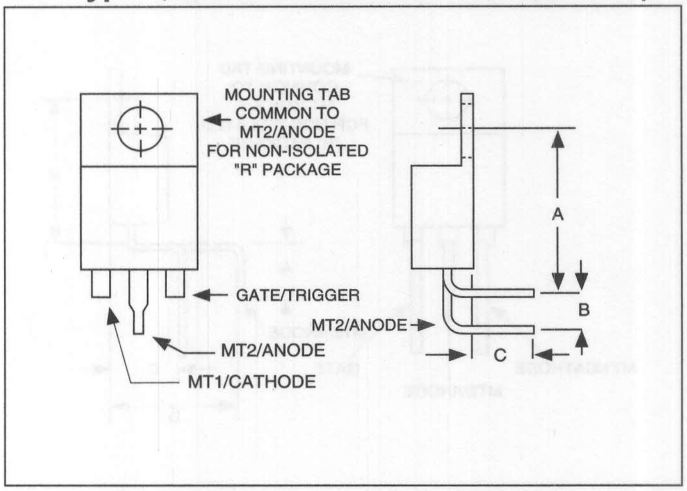
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.175		4.45	
B	.542	.582	13.77	14.78
C	.167	.207	4.24	5.26
D	.355	.395	9.02	10.03

TO-220 Type 54—"R" Package (Replaces Motorola Form 4, G.E. Type 4, RCA 6206)



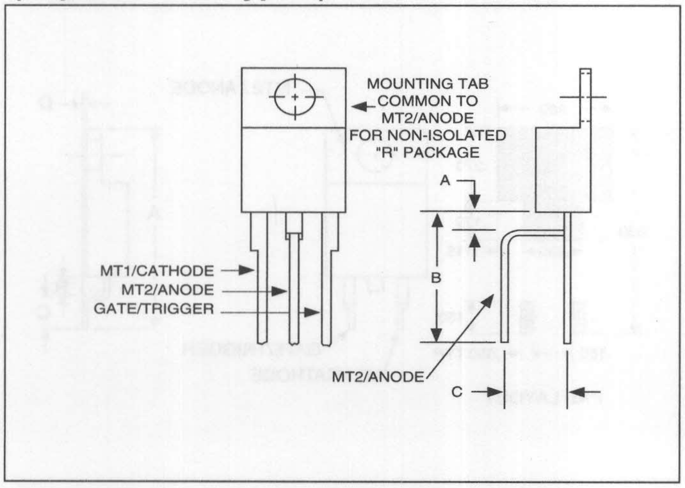
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.040	.070	1.02	1.78
B	.500		12.7	

TO-220 Type 56—"R" or "L" Package (Replaces G.E. Type 6, Motorola Lead Form 3, RCA 6221)



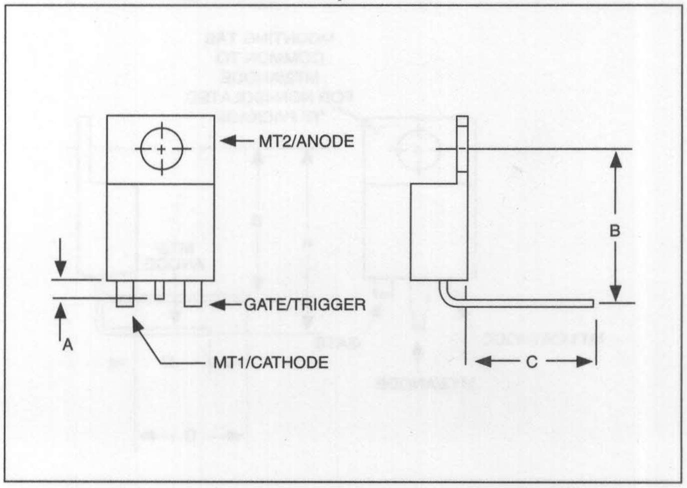
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.570	.590	14.48	14.99
B	.120	.130	3.05	3.30
C	.172	.202	4.37	5.13

TO-220 Type 55—"R" or "L" Package (Replaces G.E. Type 5)



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.065	.095	1.65	2.41
B	.353	.433	8.97	11.0
C	.115	.130	2.92	3.30

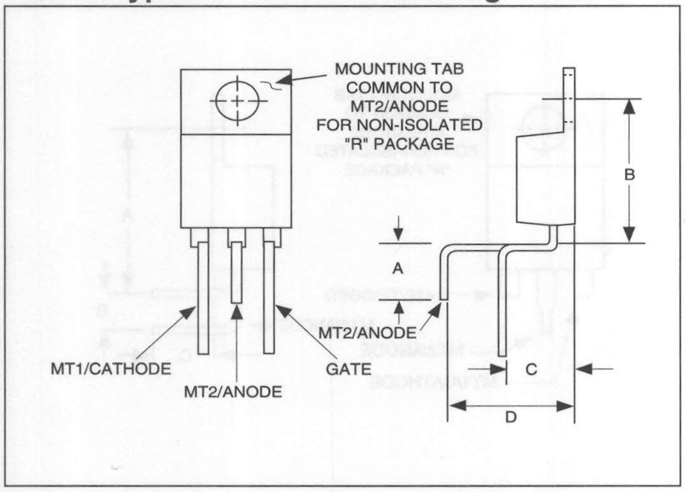
TO-220 Type 57—"R" Package (Similar to TO-66, Gate-Cathode Reversed)



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.040	.070	1.02	1.78
B	.570	.590	14.48	14.99
C	.340	.422	8.64	10.72

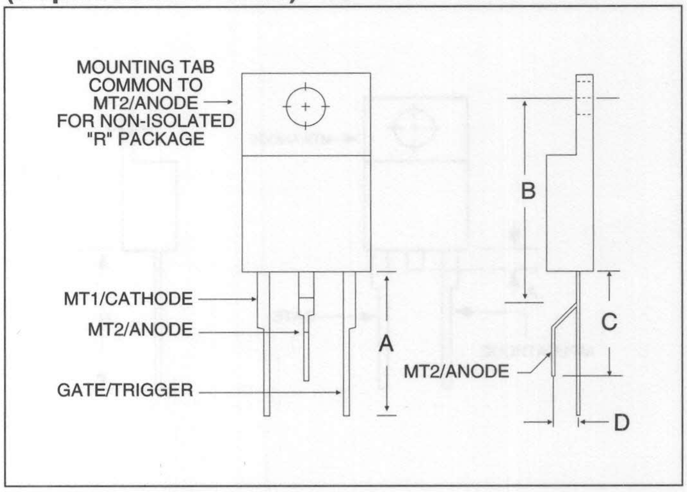
Lead Form Dimensions

TO-220 Type 58—"R" or "L" Package



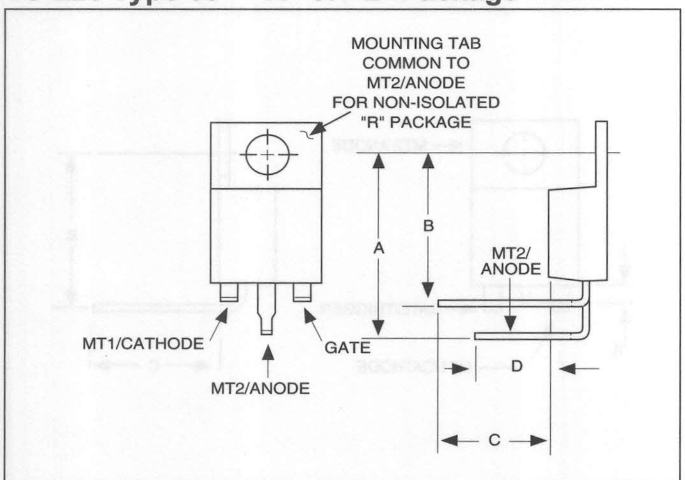
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.175		4.45	
B	.542	.582	13.77	14.78
C	.167	.207	4.24	5.26
D	.355	.395	9.02	10.03

TO-220 Type 65—"R" or "L" Package (Replaces RCA 6210)



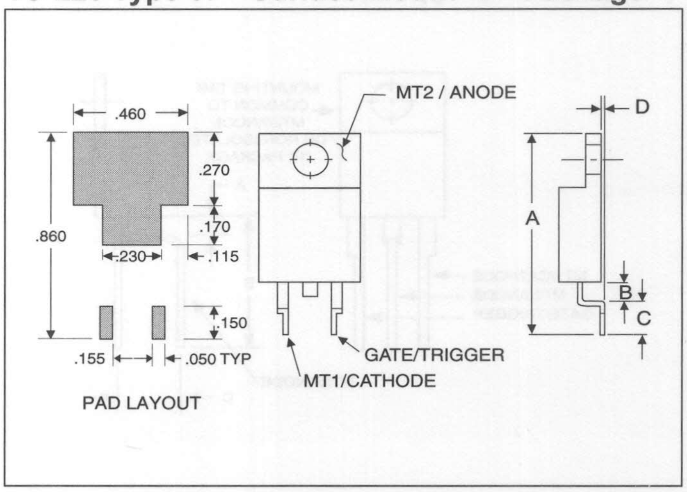
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.500	.562	12.70	14.27
B	.580	.620	14.73	15.75
C	.300		7.62	
D	.080	.120	2.03	3.05

TO-220 Type 59—"R" or "L" Package



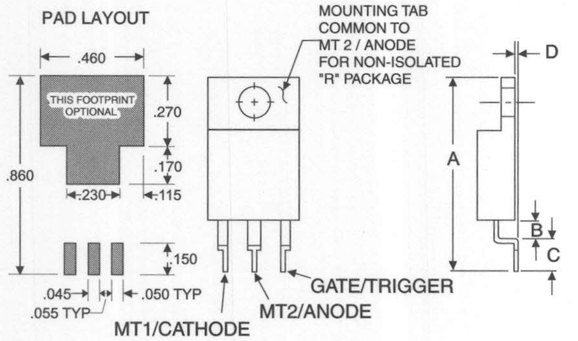
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.685	.725	17.40	18.42
B	.558	.598	14.17	15.19
C	.375		9.53	
D	.250		6.35	

TO-220 Type 67—Surface Mount "R" Package



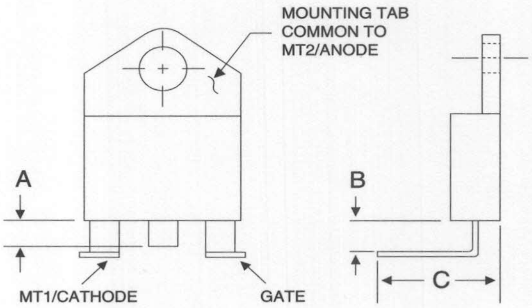
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.780	.850	19.05	21.59
B	.080	.100	2.03	2.54
C	.110	.130	2.79	3.30
D		.013		.33

TO-220 Type 68—Surface Mount “R” or “L” Package



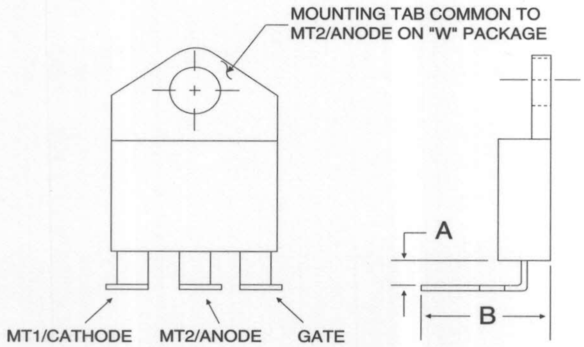
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.780	.850	19.05	21.59
B	.080	.100	2.03	2.54
C	.110	.130	2.79	3.30
D		.013		.33

TO-218 Type 82—”M” and “W” Packages



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A		.095		2.41
B	.080	.120	2.03	3.05
C	.580	.640	14.73	16.26

TO-218 Type 81—”K,” “M,” “J,” or “W” Packages



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.080	.120	2.03	3.05
B	.580	.640	14.73	16.26

Notes

Packing Options

Triacs, Quadracs, SCRs, Sidacs, and Diacs

Packing options for Thyristor devices listed in this catalog include:

- Reel Pack
- Ammo Pack
- Tube Pack
- Embossed Carrier

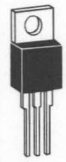
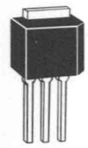
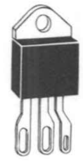
The table on page 12-2 indicates the options available for each package type.

Sample Instructions for Choosing a Packing Option

1. If selecting an "L401E6" (sensitive gate, 400 Volt, 1 Amp Triac in a TO-92 package), choose one of the options available for that device:
   - Bulk packed in 2,000 quantity
   - Tape and Reel with 2,000 parts per reel
   - Tape and Ammo with 2,000 parts per box
2. Add the designated code as a suffix to the device number, such as "L401E6 RP" if selecting Tape and Reel or "L401E6 AP" if selecting Tape and Ammo. (Bulk packing requires no suffix.)

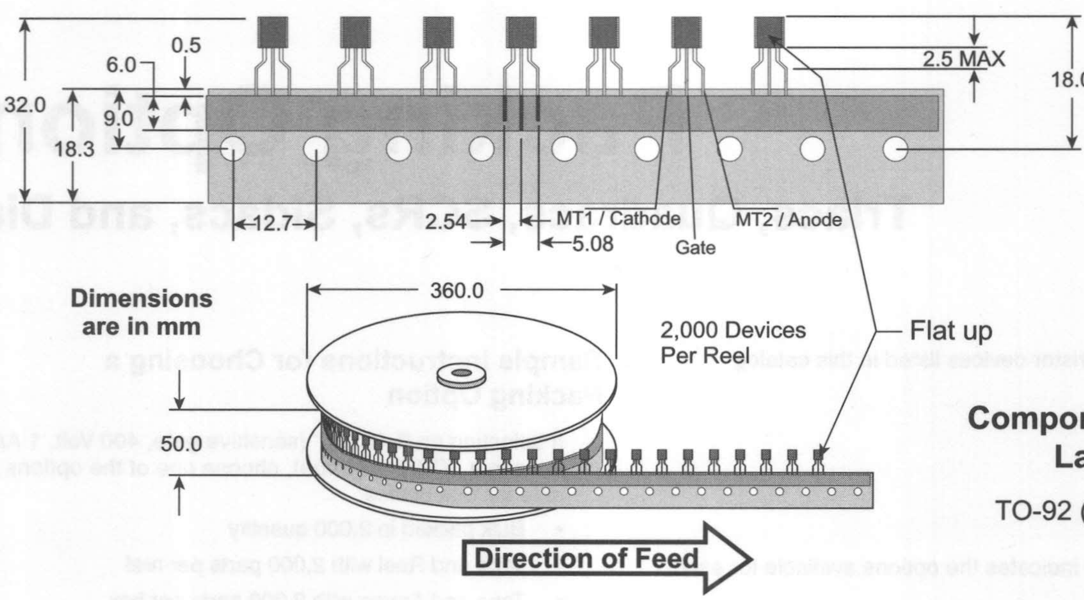
Packing Options

Package Type and Packing Options

	Package Type						
	TO-92	**TO-220**	**TO-202**	**TO-218**	**DO-214**	**DO-35**	**DO-15X**
Standard Packing Available	E 	L, R 	F 	K, J, M, W 	C 	HT 	G 
Bulk Pack	Std 2000	Std 500	Std 500	Std 250	Std 5000	Std 5000	Std 1000
Tape & Reel	RP 2000		Type 2 RP 700			RP 5000	RP 5000
Tape & Ammo	AP 2000						
Tube Pack	*	*	*	*			
Emb Carrier					RP 2500		

* Contact factory for Tube Packed availability.

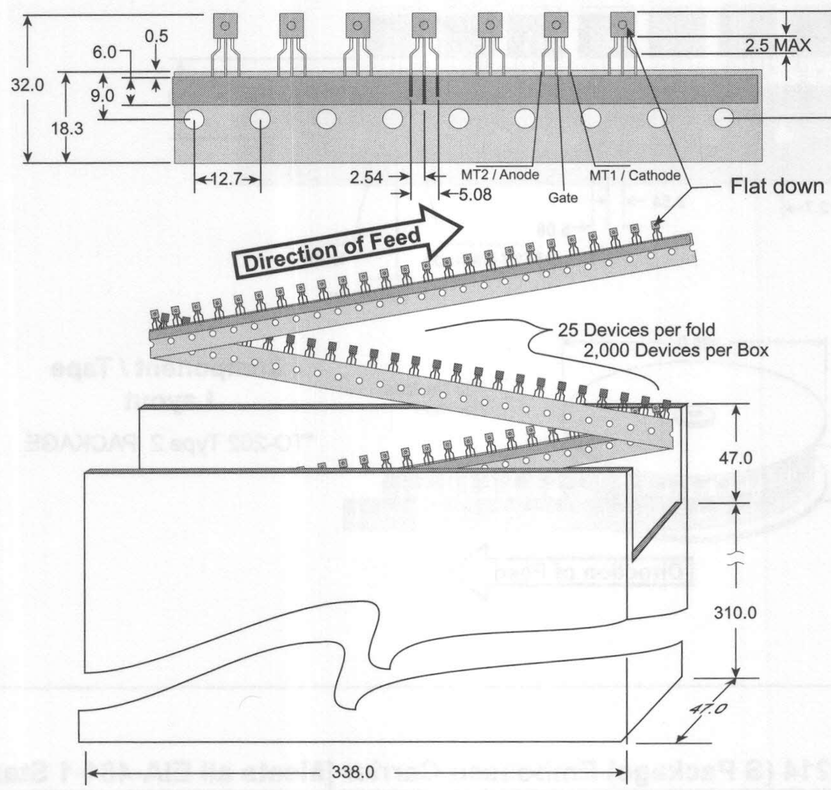
Standard Reel Pack (RP) Radial Leads [Meets all EIA-468-B 1994 Standards]



Component / Tape Layout

TO-92 (.1" spacing)

Standard Ammo Pack (AP) Radial Leaded [Meets all EIA-468-B 1994 Standards]

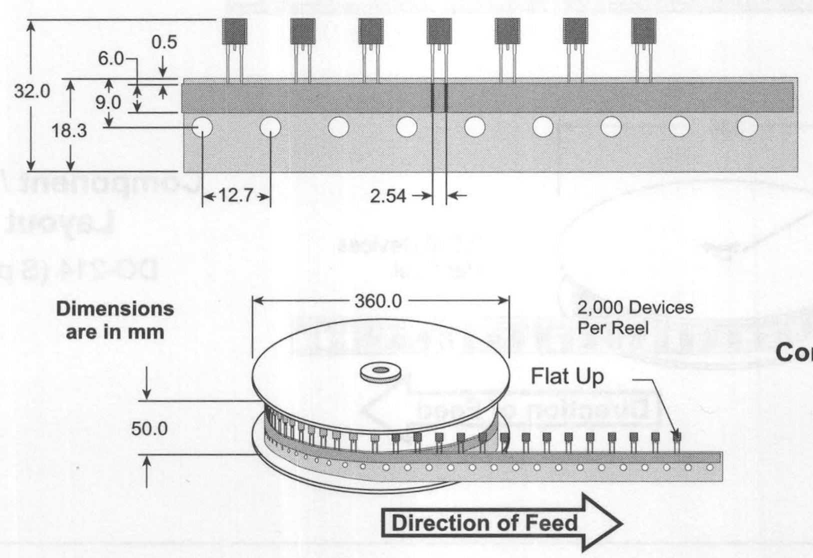


Dimensions are in mm

Component / Tape Layout

TO-92 (.1" spacing)

Standard Reel Pack (RP) TO-92 (2 Leads) Type 70 [Meets all EIA-468-B 1994 Standards]



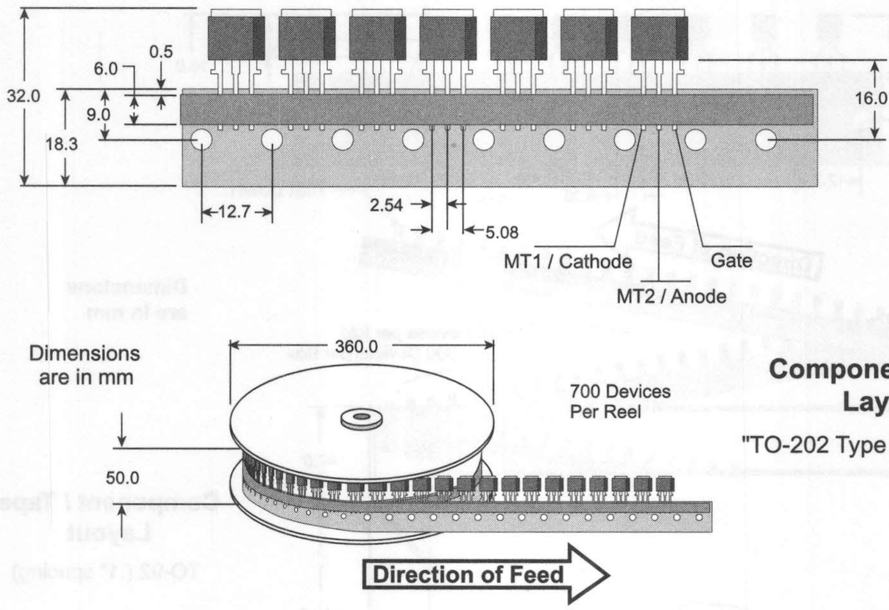
Dimensions are in mm

Component / Tape Layout

TO-92 (2 leads)
(TYPE 70)

Packing Options

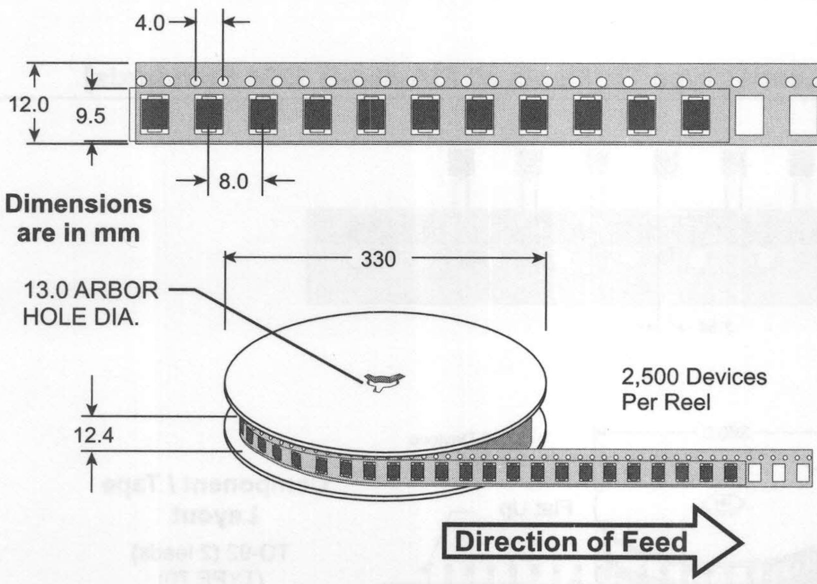
Standard Reel Pack (RP) TO-202 TYPE 2 [Meets all EIA-468-B 1994 Standards]



Component / Tape Layout

"TO-202 Type 2 PACKAGE

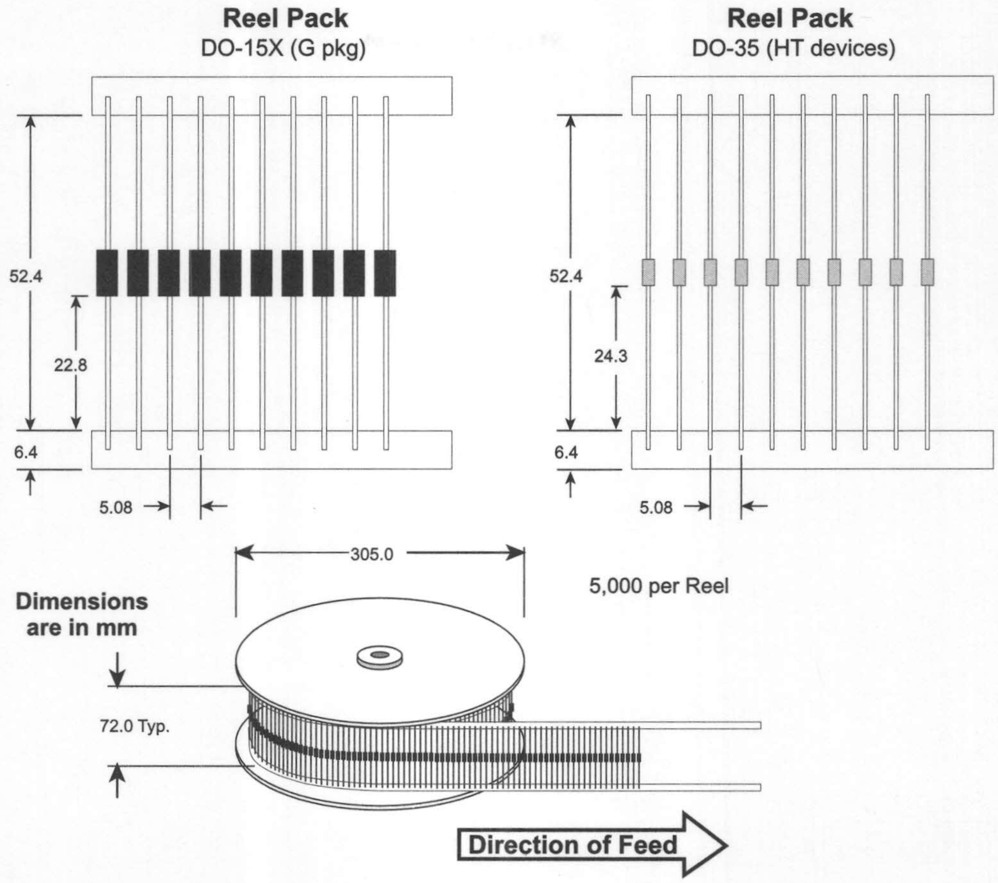
Standard Reel Pack (RP) DO-214 (S Package) Embossed Carrier [Meets all EIA-481-1 Standards]



Component / Tape Layout

DO-214 (S pkg)

Standard Reel pack (RP) Axial Packages [Meets all EIA RS-296 Standards]



Notes

Cross Reference Guide

Triacs, SCRs, Diacs, Sidacs, and Rectifiers (Suggested Teccor Replacements for JEDEC and Industry House Numbers)

How To Use This Guide

This Cross Reference Guide will help you determine the competitive products that Teccor supplies on either a DIRECT REPLACEMENT or SUGGESTED REPLACEMENT basis.

Teccor offers replacements for most competitive devices. If you do not find a desired competitive product type listed, please contact the factory for information on recent additions to this list.

On the following pages, listed in alphanumeric order, you will find:

- Competitive product number
- Teccor device part number
- "D" indicating the Direct replacement (Teccor device meets or exceeds the electrical and mechanical specifications of the competitive device); "S" indicates a Suggested replacement (The suggested replacements in this guide represent the nearest Teccor equivalent for the product listed and in most instances are replacements. However, Teccor assumes no responsibility and does not guarantee that the replacements are exact; only that the replacements will meet the terms of its applicable published written specifications. The pertinent Teccor specification sheet should be used as the principle tool for actual replacements.)
- Teccor package type

For additional assistance, contact your nearest Teccor distributor, sales representative, or the factory.

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
03P05M	EC103A	S	TO-92 (ISOL)
03P1M	EC103A	S	TO-92 (ISOL)
03P2M	EC103B	S	TO-92 (ISOL)
03P3M	EC103C	S	TO-92 (ISOL)
03P4M	EC103D	S	TO-92 (ISOL)
03P5M	EC103E	S	TO-92 (ISOL)
2N1595	S051E	S	TO-92 (ISOL)
2N1596	S101E	S	TO-92 (ISOL)
2N1597	S201E	S	TO-92 (ISOL)
2N1598	S401E	S	TO-92 (ISOL)
2N1599	S401E	S	TO-92 (ISOL)
2N2323	TCR22-2 75	S	TO-92 (ISOL)
2N3001	EC103A	S	TO-92 (ISOL)
2N3002	EC103A	S	TO-92 (ISOL)
2N3003	EC103A	S	TO-92 (ISOL)
2N3004	EC103B	S	TO-92 (ISOL)
2N3005	EC103A	D	TO-92 (ISOL)
2N3006	EC103A	D	TO-92 (ISOL)
2N3007	EC103A	D	TO-92 (ISOL)
2N3008	EC103B	D	TO-92 (ISOL)
2N3228	S2006R	S	TO-220 (N.ISOL)
2N3525	S4006R	S	TO-220 (N.ISOL)
2N3528	S2006F1	S	TO-202 (N.ISOL)
2N3529	S4006F1	S	TO-202 (N.ISOL)
2N4101	S6006L	S	TO-220 (ISOL)
2N4102	S6006F1	S	TO-202 (N.ISOL)
2N4441	S0508R	S	TO-220 (N.ISOL)
2N4442	S2008R	S	TO-220 (N.ISOL)
2N4443	S4008R	S	TO-220 (N.ISOL)
2N4444	S6008R	S	TO-220 (N.ISOL)
2N5060	2N5060	D	TO-92 (ISOL)
2N5061	2N5061	D	TO-92 (ISOL)
2N5062	2N5062	D	TO-92 (ISOL)
2N5063	2N5063	D	TO-92 (ISOL)
2N5064	2N5064	D	TO-92 (ISOL)
2N5754	Q2004F41	S	TO-202 (N.ISOL)
2N5755	Q2004F41	S	TO-202 (N.ISOL)
2N5756	Q4004F41	S	TO-202 (N.ISOL)
2N6068	Q2004F41	S	TO-202 (N.ISOL)
2N6068A	L2004F51	S	TO-202 (N.ISOL)
2N6068B	L2004F31	S	TO-202 (N.ISOL)
2N6069	Q2004F41	S	TO-202 (N.ISOL)
2N6069A	L2004F51	S	TO-202 (N.ISOL)
2N6069B	L2004F31	S	TO-202 (N.ISOL)
2N6070	Q2004F41	S	TO-202 (N.ISOL)
2N6070A	L2004F51	S	TO-202 (N.ISOL)
2N6070B	L2004F31	S	TO-202 (N.ISOL)
2N6071	Q2004F41	S	TO-202 (N.ISOL)
2N6071A	L2004F51	S	TO-202 (N.ISOL)
2N6071B	L2004F31	S	TO-202 (N.ISOL)
2N6072	Q4004F41	S	TO-202 (N.ISOL)
2N6072A	L4004F51	S	TO-202 (N.ISOL)
2N6072B	L4004F31	S	TO-202 (N.ISOL)
2N6073	Q4004F41	S	TO-202 (N.ISOL)
2N6073A	L4004F51	S	TO-202 (N.ISOL)
2N6073B	L4004F31	S	TO-202 (N.ISOL)
2N6074	Q5004F41	S	TO-202 (N.ISOL)
2N6074A	L6004F51	S	TO-202 (N.ISOL)
2N6074B	L6004F31	S	TO-202 (N.ISOL)
2N6075	Q6004F41	S	TO-202 (N.ISOL)
2N6075A	L6004F51	S	TO-202 (N.ISOL)
2N6075B	L6004F31	S	TO-202 (N.ISOL)
2N6236	T106F1	S	TO-202 (N.ISOL)
2N6237	T106F1	S	TO-202 (N.ISOL)
2N6238	T106A1	S	TO-202 (N.ISOL)
2N6239	T106B1	S	TO-202 (N.ISOL)
2N6240	T106D1	S	TO-202 (N.ISOL)
2N6241	T106M1	S	TO-202 (N.ISOL)
2N6342	Q2008R4	S	TO-220 (N.ISOL)
2N6342A	Q2012RH5	S	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
2N6343	Q4008R4	S	TO-220 (N.ISOL)
2N6343A	Q4012RH5	S	TO-220 (N.ISOL)
2N6344	Q6008R5	S	TO-220 (N.ISOL)
2N6344A	Q6012RH5	S	TO-220 (N.ISOL)
2N6345	Q8008R5	S	TO-220 (N.ISOL)
2N6345A	Q8012RH5	S	TO-220 (N.ISOL)
2N6346A	Q2015R5	S	TO-220 (N.ISOL)
2N6347A	Q4015R5	S	TO-220 (N.ISOL)
2N6348A	Q6015R5	S	TO-220 (N.ISOL)
2N6349A	Q8015R5	S	TO-220 (N.ISOL)
2N6394	S0512R	D	TO-220 (N.ISOL)
2N6395	S1012R	D	TO-220 (N.ISOL)
2N6396	S2012R	D	TO-220 (N.ISOL)
2N6397	S4012R	D	TO-220 (N.ISOL)
2N6398	S6012R	D	TO-220 (N.ISOL)
2N6399	S8012R	D	TO-220 (N.ISOL)
2N6400	S0516R	D	TO-220 (N.ISOL)
2N6401	S1016R	D	TO-220 (N.ISOL)
2N6402	S2016R	D	TO-220 (N.ISOL)
2N6403	S4016R	D	TO-220 (N.ISOL)
2N6404	S6016R	D	TO-220 (N.ISOL)
2N6405	S8016R	D	TO-220 (N.ISOL)
2N6504	S0525R	D	TO-220 (N.ISOL)
2N6505	S1025R	D	TO-220 (N.ISOL)
2N6506	S2025R	D	TO-220 (N.ISOL)
2N6507	S4025R	D	TO-220 (N.ISOL)
2N6508	S6025R	D	TO-220 (N.ISOL)
2N6509	S8025R	D	TO-220 (N.ISOL)
2N6564	2N6564	D	TO-92 (ISOL)
2N6564	EC103C	S	TO-92 (ISOL)
2N6565	2N6565	D	TO-92 (ISOL)
2N6565	EC103D	S	TO-92 (ISOL)
2N877	EC103A	S	TO-92 (ISOL)
2N878	EC103A	S	TO-92 (ISOL)
2N879	EC103A	S	TO-92 (ISOL)
2N880	EC103B	S	TO-92 (ISOL)
2N881	EC103B	S	TO-92 (ISOL)
2N885	2N5060	D	TO-92 (ISOL)
2N886	2N5061	D	TO-92 (ISOL)
2N887	2N5062	D	TO-92 (ISOL)
2N888	2N5063	D	TO-92 (ISOL)
2N889	2N5064	D	TO-92 (ISOL)
2P05M	T106F1	S	TO-202 (N.ISOL)
2P1M	T106A1	S	TO-202 (N.ISOL)
2P2M	T106B1	S	TO-202 (N.ISOL)
2P4M	T106D1	S	TO-202 (N.ISOL)
2P5M	T106E1	S	TO-202 (N.ISOL)
2P6M	T106M1	S	TO-202 (N.ISOL)
40431	Q2006LT	S	TO-220 (ISOL)
5P05M	S0508R	S	TO-220 (N.ISOL)
5P1M	S1008R	S	TO-220 (N.ISOL)
5P2M	S2008R	S	TO-220 (N.ISOL)
5P4M	S4008R	S	TO-220 (N.ISOL)
5P5M	S5008R	S	TO-220 (N.ISOL)
5P6M	S6008R	S	TO-220 (N.ISOL)
8T04HA	Q2004F41	D	TO-202 (N.ISOL)
8T04SH	L2004F81	S	TO-202 (N.ISOL)
8T14HA	Q2004F41	D	TO-202 (N.ISOL)
8T14SH	L2004F81	S	TO-202 (N.ISOL)
8T24HA	Q2004F41	D	TO-202 (N.ISOL)
8T24SH	L2004F81	S	TO-202 (N.ISOL)
8T34HA	Q4004F41	D	TO-202 (N.ISOL)
8T34SH	L4004F81	S	TO-202 (N.ISOL)
8T44HA	Q4004F41	D	TO-202 (N.ISOL)
8T44SH	L4004F81	S	TO-202 (N.ISOL)
8T54HA	Q6004F41	D	TO-202 (N.ISOL)
8T64HA	Q6004F41	D	TO-202 (N.ISOL)
8T64SH	L6004F81	S	TO-202 (N.ISOL)
AC03BGM	Q2004F41	S	TO-202 (N.ISOL)
AC03DGM	Q4004F41	S	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
AC03EGM	Q5004F41	S	TO-202 (N.ISOL)
AC03FGM	Q6004F41	S	TO-202 (N.ISOL)
AC08BGM	Q2008R5	S	TO-220 (N.ISOL)
AC08BSM	Q2008LH4	S	TO-220 (ISOL)
AC08DGM	Q4008R4	S	TO-220 (N.ISOL)
AC08DSM	Q4008LH4	S	TO-220 (ISOL)
AC08EGM	Q5008R4	S	TO-220 (N.ISOL)
AC08ESM	Q5008LH4	S	TO-220 (ISOL)
AC08FGM	Q6008R5	S	TO-220 (N.ISOL)
AC08FSM	Q6008LH4	S	TO-220 (ISOL)
AC10BGML	Q2010RH5	S	TO-220 (N.ISOL)
AC10BSM	Q2010LH5	S	TO-220 (ISOL)
AC10DGML	Q4010RH5	S	TO-220 (N.ISOL)
AC10DSM	Q4010LH5	S	TO-220 (ISOL)
AC10EGML	Q5010RH5	S	TO-220 (N.ISOL)
AC10ESM	Q5010LH5	S	TO-220 (ISOL)
AC10FGML	Q6010RH5	S	TO-220 (N.ISOL)
AC10FSM	Q6010LH5	S	TO-220 (ISOL)
AC12BGML	Q2012RH5	S	TO-220 (N.ISOL)
AC12BSM	Q2012LH5	S	TO-220 (ISOL)
AC12DGML	Q4012RH5	S	TO-220 (N.ISOL)
AC12DSM	Q4012LH5	S	TO-220 (ISOL)
AC12EGML	Q5012RH5	S	TO-220 (N.ISOL)
AC12ESM	Q5012LH5	S	TO-220 (ISOL)
AC12FGML	Q6012RH5	S	TO-220 (N.ISOL)
AC12FSM	Q6012LH5	S	TO-220 (ISOL)
AC16BGM	Q2015R5	S	TO-220 (N.ISOL)
AC16BSM	Q2015L5	S	TO-220 (ISOL)
AC16DGM	Q4015R5	S	TO-220 (N.ISOL)
AC16DSM	Q4015L5	S	TO-220 (ISOL)
AC16EGM	Q5015R5	S	TO-220 (N.ISOL)
AC16ESM	Q5015L5	S	TO-220 (ISOL)
AC16FGM	Q6015R5	S	TO-220 (N.ISOL)
AC16FSM	Q6015L5	S	TO-220 (ISOL)
AC25B1FL	Q2025P	S	FASTPAK (ISOL)
AC25D1FL	Q4025P	S	FASTPAK (ISOL)
AC25E1FL	Q5025P	S	FASTPAK (ISOL)
AC25F1FL	Q6025P	S	FASTPAK (ISOL)
BT136-500	Q5004F41	S	TO-202 (N.ISOL)
BT136-500D	L6004F61	S	TO-202 (N.ISOL)
BT136-500E	L6004F81	S	TO-202 (N.ISOL)
BT136-500F	Q5004F41	S	TO-202 (N.ISOL)
BT136-500G	Q5004F41	S	TO-202 (N.ISOL)
BT136-600	Q6004F41	S	TO-202 (N.ISOL)
BT136-600D	L6004F61	S	TO-202 (N.ISOL)
BT136-600E	L6004F81	S	TO-202 (N.ISOL)
BT136-600F	Q6004F41	S	TO-202 (N.ISOL)
BT136-600G	Q6004F41	S	TO-202 (N.ISOL)
BT136-800	Q8004L4	S	TO-220 (ISOL)
BT136-800F	Q8004L4	S	TO-220 (ISOL)
BT136-800G	Q8004L4	S	TO-220 (ISOL)
BT136F-500	Q5004L4	S	TO-220 (ISOL)
BT136F-500D	L6004L6	S	TO-220 (ISOL)
BT136F-500E	L6004L8	S	TO-220 (ISOL)
BT136F-500F	Q5004L4	S	TO-220 (ISOL)
BT136F-500G	Q5004L4	S	TO-220 (ISOL)
BT136F-600	Q6004L4	S	TO-220 (ISOL)
BT136F-600D	L6004L6	S	TO-220 (ISOL)
BT136F-600E	L6004L8	S	TO-220 (ISOL)
BT136F-600F	Q6004L4	S	TO-220 (ISOL)
BT136F-600G	Q6004L4	S	TO-220 (ISOL)
BT136F-800	Q8004L4	S	TO-220 (ISOL)
BT136F-800F	Q8004L4	S	TO-220 (ISOL)
BT136F-800G	Q8004L4	S	TO-220 (ISOL)
BT136X-500	Q5004L4	S	TO-220 (ISOL)
BT136X-500D	L6004L6	S	TO-220 (ISOL)
BT136X-500E	L6004L8	S	TO-220 (ISOL)
BT136X-500F	Q5004L4	S	TO-220 (ISOL)
BT136X-500G	Q5004L4	S	TO-220 (ISOL)
BT136X-600	Q6004L4	S	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BT136X-600D	L6004L6	S	TO-220 (ISOL)
BT136X-600E	L6004L8	S	TO-220 (ISOL)
BT136X-600F	Q6004L4	S	TO-220 (ISOL)
BT136X-600G	Q6004L4	S	TO-220 (ISOL)
BT136X-800	Q8004L4	S	TO-220 (ISOL)
BT136X-800F	Q8004L4	S	TO-220 (ISOL)
BT136X-800G	Q8004L4	S	TO-220 (ISOL)
BT137-500	Q5008R4	S	TO-220 (N.ISOL)
BT137-500D	L6008L6	S	TO-220 (ISOL)
BT137-500E	L6008L8	S	TO-220 (ISOL)
BT137-500F	Q5008R4	S	TO-220 (N.ISOL)
BT137-500G	Q5008R4	S	TO-220 (N.ISOL)
BT137-600D	L6008L6	S	TO-220 (ISOL)
BT137-600E	L6008L8	S	TO-220 (ISOL)
BT137-600G	Q6008R5	S	TO-220 (N.ISOL)
BT137-800G	Q8008R5	S	TO-220 (N.ISOL)
BT137F-500	Q5008L4	S	TO-220 (ISOL)
BT137F-500D	L6008L6	S	TO-220 (ISOL)
BT137F-500E	L6008L8	S	TO-220 (ISOL)
BT137F-500F	Q5008L4	S	TO-220 (ISOL)
BT137F-500G	Q5008L4	S	TO-220 (ISOL)
BT137F-600D	L6008L6	S	TO-220 (ISOL)
BT137F-600E	L6008L8	S	TO-220 (ISOL)
BT137F-600G	Q6008L5	S	TO-220 (ISOL)
BT137F-800G	Q8008L5	S	TO-220 (ISOL)
BT137X-500	Q5008L4	S	TO-220 (ISOL)
BT137X-500D	L6008L6	S	TO-220 (ISOL)
BT137X-500E	L6008L8	S	TO-220 (ISOL)
BT137X-500F	Q5008L4	S	TO-220 (ISOL)
BT137X-500G	Q5008L4	S	TO-220 (ISOL)
BT137X-600D	L6008L6	S	TO-220 (ISOL)
BT137X-600E	L6008L8	S	TO-220 (ISOL)
BT137X-600G	Q6008L5	S	TO-220 (ISOL)
BT137X-800G	Q8008L5	S	TO-220 (ISOL)
BT138-500G	Q5015R5	S	TO-220 (N.ISOL)
BT138-600G	Q6015R5	S	TO-220 (N.ISOL)
BT138-800G	Q8015R5	S	TO-220 (N.ISOL)
BT138F-500G	Q5015L5	S	TO-220 (ISOL)
BT138F-600G	Q6015L5	S	TO-220 (ISOL)
BT138F-800G	Q8015L5	S	TO-220 (ISOL)
BT138X-500G	Q5015L5	S	TO-220 (ISOL)
BT138X-600G	Q6015L5	S	TO-220 (ISOL)
BT138X-800G	Q8015L5	S	TO-220 (ISOL)
BT139-500G	Q5015R5	S	TO-220 (N.ISOL)
BT139-600G	Q6015R5	S	TO-220 (N.ISOL)
BT139-800G	Q8015R5	S	TO-220 (N.ISOL)
BT139F-500G	Q5015L5	S	TO-220 (ISOL)
BT139F-600G	Q6015L5	S	TO-220 (ISOL)
BT139F-800G	Q8015L5	S	TO-220 (ISOL)
BT139X-500G	Q5015L5	S	TO-220 (ISOL)
BT139X-500H	Q5015L6	S	TO-220 (ISOL)
BT139X-600G	Q6015L5	S	TO-220 (ISOL)
BT139X-600H	Q6015L6	S	TO-220 (ISOL)
BT139X-800G	Q8015L5	S	TO-220 (ISOL)
BT139X-800H	Q8015L6	S	TO-220 (ISOL)
BT145-500R	Q6025R	S	TO-220 (N.ISOL)
BT145-600R	Q6025R	S	TO-220 (N.ISOL)
BT145-800R	Q8025R	S	TO-220 (N.ISOL)
BT149B	EC103B	S	TO-92 (ISOL)
BT149D	EC103D	S	TO-92 (ISOL)
BT149E	EC103E	S	TO-92 (ISOL)
BT149G	EC103M	S	TO-92 (ISOL)
BT150-500R	T106E1	S	TO-202 (N.ISOL)
BT150-600R	T106M1	S	TO-202 (N.ISOL)
BT151-500R	S6010R	S	TO-220 (N.ISOL)
BT151-650R	S8010R	S	TO-220 (N.ISOL)
BT151-800R	S8010R	S	TO-220 (N.ISOL)
BT151X-500	S6010L	S	TO-220 (ISOL)
BT151X-650	S8010L	S	TO-220 (ISOL)
BT151X-800	S8010L	S	TO-220 (ISOL)

Cross Reference Guide

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BT152-400R	S4020L	S	TO-220 (ISOL)
BT152-600R	S6020L	S	TO-220 (ISOL)
BT152-800R	S8020L	S	TO-220 (ISOL)
BT168B	EC103B	S	TO-92 (ISOL)
BT168D	EC103D	S	TO-92 (ISOL)
BT168E	EC103E	S	TO-92 (ISOL)
BT168G	EC103M	S	TO-92 (ISOL)
BT169B	EC103B	D	TO-92 (ISOL)
BT169D	EC103D	D	TO-92 (ISOL)
BT169E	EC103E	D	TO-92 (ISOL)
BT169G	EC103M	D	TO-92 (ISOL)
BT300-500R	S6008R	S	TO-220 (N.ISOL)
BT300-600R	S6008R	S	TO-220 (N.ISOL)
BT300-800R	S8008R	S	TO-220 (N.ISOL)
BTA04-200A	L2004L8	D	TO-220 (ISOL)
BTA04-200D	L2004L6	D	TO-220 (ISOL)
BTA04-200GP	Q2004L4	S	TO-220 (ISOL)
BTA04-200S	L2004L6	D	TO-220 (ISOL)
BTA04-200T	L2004L5	D	TO-220 (ISOL)
BTA04-400A	L4004L8	D	TO-220 (ISOL)
BTA04-400D	L4004L6	D	TO-220 (ISOL)
BTA04-400GP	Q4004L4	S	TO-220 (ISOL)
BTA04-400S	L4004L6	D	TO-220 (ISOL)
BTA04-400T	L4004L5	D	TO-220 (ISOL)
BTA04-600A	L6004L8	D	TO-220 (ISOL)
BTA04-600D	L6004L6	D	TO-220 (ISOL)
BTA04-600GP	Q6004L4	S	TO-220 (ISOL)
BTA04-600S	L6004L6	D	TO-220 (ISOL)
BTA04-600T	L6004L5	D	TO-220 (ISOL)
BTA06-200A	L2006L8	D	TO-220 (ISOL)
BTA06-200B	Q2006L4	S	TO-220 (ISOL)
BTA06-200C	Q2006L4	S	TO-220 (ISOL)
BTA06-200D	L2006L6	D	TO-220 (ISOL)
BTA06-200GP	Q2006L4	S	TO-220 (ISOL)
BTA06-200S	L2006L6	D	TO-220 (ISOL)
BTA06-200SW	L2006L8	D	TO-220 (ISOL)
BTA06-200T	L2006L5	D	TO-220 (ISOL)
BTA06-200TW	L2006L6	D	TO-220 (ISOL)
BTA06-400A	L4006L8	D	TO-220 (ISOL)
BTA06-400B	Q4006L4	S	TO-220 (ISOL)
BTA06-400C	Q4006L4	S	TO-220 (ISOL)
BTA06-400D	L4006L6	D	TO-220 (ISOL)
BTA06-400GP	Q4006L4	S	TO-220 (ISOL)
BTA06-400S	L4006L6	D	TO-220 (ISOL)
BTA06-400SW	L4006L8	D	TO-220 (ISOL)
BTA06-400T	L4006L5	D	TO-220 (ISOL)
BTA06-400TW	L4006L6	D	TO-220 (ISOL)
BTA06-600A	L6006L8	D	TO-220 (ISOL)
BTA06-600B	Q6006L5	S	TO-220 (ISOL)
BTA06-600C	Q6006L5	S	TO-220 (ISOL)
BTA06-600D	L6006L6	D	TO-220 (ISOL)
BTA06-600GP	Q6006L5	S	TO-220 (ISOL)
BTA06-600S	L6006L6	D	TO-220 (ISOL)
BTA06-600SW	L6006L8	D	TO-220 (ISOL)
BTA06-600T	L6006L5	S	TO-220 (ISOL)
BTA06-600TW	L6006L6	D	TO-220 (ISOL)
BTA06-700B	Q7006L5	S	TO-220 (ISOL)
BTA06-700BW	Q7006LH4	S	TO-220 (ISOL)
BTA06-700C	Q7006L5	D	TO-220 (ISOL)
BTA06-700CW	Q7006LH4	D	TO-220 (ISOL)
BTA06-800B	Q8006L5	S	TO-220 (ISOL)
BTA06-800BW	Q8006LH4	S	TO-220 (ISOL)
BTA06-800C	Q8006L5	S	TO-220 (ISOL)
BTA06-800CW	Q8006LH4	D	TO-220 (ISOL)
BTA08-200A	L2008L8	D	TO-220 (ISOL)
BTA08-200B	Q2008L4	S	TO-220 (ISOL)
BTA08-200C	Q2008L4	S	TO-220 (ISOL)
BTA08-200S	L2008L6	D	TO-220 (ISOL)
BTA08-200SW	L2008L8	D	TO-220 (ISOL)
BTA08-200TW	L2008L6	D	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BTA08-400A	L4008L8	D	TO-220 (ISOL)
BTA08-400B	Q4008L4	S	TO-220 (ISOL)
BTA08-400BW	Q4008LH4	S	TO-220 (ISOL)
BTA08-400C	Q4008L4	S	TO-220 (ISOL)
BTA08-400CW	Q4008LH4	D	TO-220 (ISOL)
BTA08-400S	L4008L6	D	TO-220 (ISOL)
BTA08-400SW	L4008L8	D	TO-220 (ISOL)
BTA08-400TW	L4008L6	D	TO-220 (ISOL)
BTA08-600A	L6008L8	D	TO-220 (ISOL)
BTA08-600B	Q6008L5	S	TO-220 (ISOL)
BTA08-600BW	Q6008LH4	S	TO-220 (ISOL)
BTA08-600C	Q6008L5	S	TO-220 (ISOL)
BTA08-600CW	Q6008LH4	D	TO-220 (ISOL)
BTA08-600S	L6008L6	D	TO-220 (ISOL)
BTA08-600SW	L6008L8	D	TO-220 (ISOL)
BTA08-600TW	L6008L6	D	TO-220 (ISOL)
BTA08-700B	Q7008L5	S	TO-220 (ISOL)
BTA08-700BW	Q7008LH4	S	TO-220 (ISOL)
BTA08-700C	Q7008L5	S	TO-220 (ISOL)
BTA08-700CW	Q7008LH4	D	TO-220 (ISOL)
BTA08-800B	Q8008L5	S	TO-220 (ISOL)
BTA08-800BW	Q8008LH4	S	TO-220 (ISOL)
BTA08-800C	Q8008L5	S	TO-220 (ISOL)
BTA08-800CW	Q8008LH4	D	TO-220 (ISOL)
BTA10-200AW	Q2010L5	S	TO-220 (ISOL)
BTA10-200B	Q2010L5	S	TO-220 (ISOL)
BTA10-200BW	Q2010LH5	D	TO-220 (ISOL)
BTA10-200C	Q2010L5	S	TO-220 (ISOL)
BTA10-200CW	Q2010LH5	S	TO-220 (ISOL)
BTA10-400AW	Q4010L5	S	TO-220 (ISOL)
BTA10-400B	Q4010L5	S	TO-220 (ISOL)
BTA10-400BW	Q4010LH5	D	TO-220 (ISOL)
BTA10-400C	Q4010L5	S	TO-220 (ISOL)
BTA10-400CW	Q4010LH5	S	TO-220 (ISOL)
BTA10-600AW	Q6010L5	S	TO-220 (ISOL)
BTA10-600B	Q6010L5	S	TO-220 (ISOL)
BTA10-600BW	Q6010LH5	D	TO-220 (ISOL)
BTA10-600C	Q6010L5	S	TO-220 (ISOL)
BTA10-600CW	Q6010LH5	S	TO-220 (ISOL)
BTA10-700AW	Q7010L5	S	TO-220 (ISOL)
BTA10-700B	Q7010L5	S	TO-220 (ISOL)
BTA10-700BW	Q7010LH5	D	TO-220 (ISOL)
BTA10-700C	Q7010L5	S	TO-220 (ISOL)
BTA10-700CW	Q7010LH5	S	TO-220 (ISOL)
BTA10-800B	Q8010L5	S	TO-220 (ISOL)
BTA10-800BW	Q8010LH5	D	TO-220 (ISOL)
BTA10-800C	Q8010L5	S	TO-220 (ISOL)
BTA10-800CW	Q8010LH5	S	TO-220 (ISOL)
BTA12-200AW	Q2015L5	S	TO-220 (ISOL)
BTA12-200B	Q2015L5	S	TO-220 (ISOL)
BTA12-200BW	Q4012LH5	D	TO-220 (ISOL)
BTA12-200C	Q2015L5	S	TO-220 (ISOL)
BTA12-400AW	Q4015L5	D	TO-220 (ISOL)
BTA12-400B	Q4015L5	S	TO-220 (ISOL)
BTA12-400BW	Q4012LH5	D	TO-220 (ISOL)
BTA12-400C	Q4015L5	S	TO-220 (ISOL)
BTA12-400CW	Q4012LH5	S	TO-220 (ISOL)
BTA12-600AW	Q6015L5	D	TO-220 (ISOL)
BTA12-600B	Q6015L5	S	TO-220 (ISOL)
BTA12-600BW	Q6012LH5	D	TO-220 (ISOL)
BTA12-600C	Q6015L5	S	TO-220 (ISOL)
BTA12-600CW	Q6012LH5	S	TO-220 (ISOL)
BTA12-700AW	Q7015L5	D	TO-220 (ISOL)
BTA12-700B	Q7015L5	S	TO-220 (ISOL)
BTA12-700BW	Q7012LH5	D	TO-220 (ISOL)
BTA12-700C	Q7015L5	S	TO-220 (ISOL)
BTA12-700CW	Q7012LH5	S	TO-220 (ISOL)
BTA12-800B	Q8015L5	S	TO-220 (ISOL)
BTA12-800BW	Q8012LH5	S	TO-220 (ISOL)
BTA12-800C	Q8015L5	S	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BTA12-800CW	Q8012LH5	S	TO-220 (ISOL)
BTA13-200B	Q2015L5	S	TO-220 (ISOL)
BTA13-400B	Q4015L5	S	TO-220 (ISOL)
BTA13-600B	Q6015L5	S	TO-220 (ISOL)
BTA13-700B	Q7015L5	S	TO-220 (ISOL)
BTA13-800B	Q8015L5	S	TO-220 (ISOL)
BTA140-500	Q5025R5	S	TO-220 (N.ISOL)
BTA140-600	Q6025R5	S	TO-220 (N.ISOL)
BTA140-800	Q8025R5	S	TO-220 (N.ISOL)
BTA16-200AW	Q2015L5	S	TO-220 (ISOL)
BTA16-200B	Q2015L5	S	TO-220 (ISOL)
BTA16-200BW	Q2015L6	S	TO-220 (ISOL)
BTA16-400AW	Q4015L5	S	TO-220 (ISOL)
BTA16-400B	Q4015L5	S	TO-220 (ISOL)
BTA16-400BW	Q4015L6	S	TO-220 (ISOL)
BTA16-600AW	Q6015L5	S	TO-220 (ISOL)
BTA16-600B	Q6015L5	S	TO-220 (ISOL)
BTA16-600BW	Q6015L6	S	TO-220 (ISOL)
BTA16-700AW	Q7015L5	S	TO-220 (ISOL)
BTA16-700B	Q7015L5	S	TO-220 (ISOL)
BTA16-700BW	Q7015L6	S	TO-220 (ISOL)
BTA16-800AW	Q8015L5	S	TO-220 (ISOL)
BTA16-800B	Q8015L5	S	TO-220 (ISOL)
BTA16-800BW	Q8015L6	S	TO-220 (ISOL)
BTA20-400BW	Q4025L6	S	TO-220 (ISOL)
BTA20-600BW	Q6025L6	S	TO-220 (ISOL)
BTA20-700BW	Q7025L6	S	TO-220 (ISOL)
BTA20-800BW	Q8025L6	S	TO-220 (ISOL)
BTA208-600B	Q6008RH4	S	TO-220 (N.ISOL)
BTA208-800B	Q8008RH4	S	TO-220 (N.ISOL)
BTA208X-600B	Q6008LH4	S	TO-220 (ISOL)
BTA208X-800B	Q8008LH4	S	TO-220 (ISOL)
BTA20C	Q4006R4	D	TO-220 (N.ISOL)
BTA20D	Q4006R4	D	TO-220 (N.ISOL)
BTA20E	Q5006R4	D	TO-220 (N.ISOL)
BTA20M	Q6006R5	D	TO-220 (N.ISOL)
BTA20N	Q8006R5	D	TO-220 (N.ISOL)
BTA212-600B	Q6012RH5	S	TO-220 (N.ISOL)
BTA212-800B	Q8012RH5	S	TO-220 (N.ISOL)
BTA212X-600B	Q6012LH5	S	TO-220 (ISOL)
BTA212X-800B	Q8012LH5	S	TO-220 (ISOL)
BTA216-600B	Q6015R6	S	TO-220 (N.ISOL)
BTA216-800B	Q8015R6	S	TO-220 (N.ISOL)
BTA216X-600B	Q6015L6	S	TO-220 (ISOL)
BTA216X-800B	Q8015L6	S	TO-220 (ISOL)
BTA21C	Q4008R4	D	TO-220 (N.ISOL)
BTA21D	Q4008R4	D	TO-220 (N.ISOL)
BTA21E	Q5008R4	D	TO-220 (N.ISOL)
BTA21M	Q6008R5	D	TO-220 (N.ISOL)
BTA21N	Q8008R5	D	TO-220 (N.ISOL)
BTA225-600B	Q6025R6	S	TO-220 (N.ISOL)
BTA225-800B	Q8025R6	S	TO-220 (N.ISOL)
BTA22B	Q2010R5	S	TO-220 (N.ISOL)
BTA22C	Q4010R5	S	TO-220 (N.ISOL)
BTA22D	Q4010R5	S	TO-220 (N.ISOL)
BTA22E	Q5010R5	S	TO-220 (N.ISOL)
BTA22M	Q6010R5	S	TO-220 (N.ISOL)
BTA23B	Q2015R5	S	TO-220 (N.ISOL)
BTA23C	Q4015R5	S	TO-220 (N.ISOL)
BTA23D	Q4015R5	S	TO-220 (N.ISOL)
BTA23E	Q5015R5	S	TO-220 (N.ISOL)
BTA23M	Q6015R5	S	TO-220 (N.ISOL)
BTA25-200A	Q2025P	S	FASTPAK (ISOL)
BTA25-200B	Q2025P	S	FASTPAK (ISOL)
BTA25-400A	Q4025P	S	FASTPAK (ISOL)
BTA25-400B	Q4025P	S	FASTPAK (ISOL)
BTA25-600A	Q6025P	S	FASTPAK (ISOL)
BTA25-600B	Q6025P	S	FASTPAK (ISOL)
BTA25-700A	Q7025P	S	FASTPAK (ISOL)
BTA25-700B	Q7025P	S	FASTPAK (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BTA25-800A	Q8025P	S	FASTPAK (ISOL)
BTA25-800B	Q8025P	S	FASTPAK (ISOL)
BTA26-200A	Q2025K6	S	TO-218 (ISOL)
BTA26-200B	Q2025K6	S	TO-218 (ISOL)
BTA26-400A	Q4025K6	S	TO-218 (ISOL)
BTA26-400B	Q4025K6	S	TO-218 (ISOL)
BTA26-400BW	Q4025K6	S	TO-218 (ISOL)
BTA26-400BW	Q4025K6	S	TO-218 (ISOL)
BTA26-600A	Q6025K6	S	TO-218 (ISOL)
BTA26-600B	Q6025K6	S	TO-218 (ISOL)
BTA26-600BW	Q6025K6	S	TO-218 (ISOL)
BTA26-600BW	Q6025K6	S	TO-218 (ISOL)
BTA26-700A	Q7025K6	S	TO-218 (ISOL)
BTA26-700B	Q7025K6	S	TO-218 (ISOL)
BTA26-700BW	Q7025K6	S	TO-218 (ISOL)
BTA26-700CW	Q7025K6	S	TO-218 (ISOL)
BTA26-800A	Q8025K6	S	TO-218 (ISOL)
BTA26-800B	Q8025K6	S	TO-218 (ISOL)
BTA26-800BW	Q8025K6	S	TO-218 (ISOL)
BTA26-800CW	Q8025K6	S	TO-218 (ISOL)
BTA40-200A	Q2040P	S	FASTPAK (ISOL)
BTA40-200B	Q2040P	S	FASTPAK (ISOL)
BTA40-400A	Q4040P	S	FASTPAK (ISOL)
BTA40-400B	Q4040P	S	FASTPAK (ISOL)
BTA40-600A	Q6040P	S	FASTPAK (ISOL)
BTA40-600B	Q6040P	S	FASTPAK (ISOL)
BTA40-700A	Q7040P	S	FASTPAK (ISOL)
BTA40-700B	Q7040P	S	FASTPAK (ISOL)
BTA41-200A	Q2040K7	S	TO-218 (ISOL)
BTA41-200B	Q2040K7	S	TO-218 (ISOL)
BTA41-400A	Q4040K7	S	TO-218 (ISOL)
BTA41-400B	Q4040K7	S	TO-218 (ISOL)
BTA41-600A	Q6040K7	S	TO-218 (ISOL)
BTA41-600B	Q6040K7	S	TO-218 (ISOL)
BTA41-700A	Q7040K7	S	TO-218 (ISOL)
BTA41-700B	Q7040K7	S	TO-218 (ISOL)
BTA41-800A	Q8040K7	S	TO-218 (ISOL)
BTA41-800B	Q8040K7	S	TO-218 (ISOL)
BTB04-200A	L2004F81	S	TO-202 (N.ISOL)
BTB04-200D	L2004F61	S	TO-202 (N.ISOL)
BTB04-200S	L2004F61	S	TO-202 (N.ISOL)
BTB04-200T	L2004F51	S	TO-202 (N.ISOL)
BTB04-400A	L4004F81	S	TO-202 (N.ISOL)
BTB04-400D	L4004F61	S	TO-202 (N.ISOL)
BTB04-400S	L4004F61	S	TO-202 (N.ISOL)
BTB04-400T	L4004F51	S	TO-202 (N.ISOL)
BTB04-600A	L6004F61	S	TO-202 (N.ISOL)
BTB04-600D	L6004F61	S	TO-202 (N.ISOL)
BTB04-600S	L6004F81	S	TO-202 (N.ISOL)
BTB04-600T	L6004F51	S	TO-202 (N.ISOL)
BTB06-200A	L2006L8	S	TO-220 (ISOL)
BTB06-200B	Q2006R4	S	TO-220 (N.ISOL)
BTB06-200C	Q2006R4	S	TO-220 (N.ISOL)
BTB06-200D	L2006L6	S	TO-220 (ISOL)
BTB06-200S	L2006L6	S	TO-220 (ISOL)
BTB06-200T	L2006L5	S	TO-220 (ISOL)
BTB06-400A	L4006L8	S	TO-220 (ISOL)
BTB06-400B	Q4006R4	S	TO-220 (N.ISOL)
BTB06-400BW	Q4006RH4	S	TO-220 (N.ISOL)
BTB06-400C	Q4006R4	S	TO-220 (N.ISOL)
BTB06-400CW	Q4006RH4	S	TO-220 (N.ISOL)
BTB06-400D	L4006L6	S	TO-220 (ISOL)
BTB06-400S	L4006L6	S	TO-220 (ISOL)
BTB06-400T	L4006L5	S	TO-220 (ISOL)
BTB06-600A	L6006L8	S	TO-220 (ISOL)
BTB06-600B	Q6006R5	S	TO-220 (N.ISOL)
BTB06-600BW	Q6006RH4	S	TO-220 (N.ISOL)
BTB06-600C	Q6006R5	S	TO-220 (N.ISOL)
BTB06-600CW	Q6006RH4	S	TO-220 (N.ISOL)
BTB06-600D	L6006L6	S	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BTB06-600S	L6006L6	S	TO-220 (ISOL)
BTB06-600T	L6006L5	S	TO-220 (ISOL)
BTB06-700B	Q7006R5	S	TO-220 (N.ISOL)
BTB06-700BW	Q7006RH4	S	TO-220 (N.ISOL)
BTB06-700C	Q7006R5	S	TO-220 (N.ISOL)
BTB06-700CW	Q7006RH4	S	TO-220 (N.ISOL)
BTB06-800B	Q8006R5	S	TO-220 (N.ISOL)
BTB06-800BW	Q8006RH4	S	TO-220 (N.ISOL)
BTB06-800C	Q8006R5	S	TO-220 (N.ISOL)
BTB06-800CW	Q8006RH4	S	TO-220 (N.ISOL)
BTB08-200A	L2008L8	S	TO-220 (ISOL)
BTB08-200B	Q2008R4	S	TO-220 (N.ISOL)
BTB08-200C	Q2008R4	S	TO-220 (N.ISOL)
BTB08-200S	L2008L6	S	TO-220 (ISOL)
BTB08-400A	L4008L8	S	TO-220 (ISOL)
BTB08-400B	Q4008R4	S	TO-220 (N.ISOL)
BTB08-400BW	Q4008RH4	S	TO-220 (N.ISOL)
BTB08-400C	Q4008R4	S	TO-220 (N.ISOL)
BTB08-400CW	Q4008RH4	S	TO-220 (N.ISOL)
BTB08-400S	L4008L6	S	TO-220 (ISOL)
BTB08-600A	L6008L8	S	TO-220 (ISOL)
BTB08-600B	Q6008R5	S	TO-220 (N.ISOL)
BTB08-600BW	Q6008RH4	S	TO-220 (N.ISOL)
BTB08-600C	Q6008R5	S	TO-220 (N.ISOL)
BTB08-600CW	Q6008RH4	S	TO-220 (N.ISOL)
BTB08-600S	L6008L6	S	TO-220 (ISOL)
BTB08-700B	Q7008R5	S	TO-220 (N.ISOL)
BTB08-700BW	Q7008RH4	S	TO-220 (N.ISOL)
BTB08-700C	Q7008R5	S	TO-220 (N.ISOL)
BTB08-700CW	Q7008RH4	S	TO-220 (N.ISOL)
BTB08-800B	Q8008R5	S	TO-220 (N.ISOL)
BTB08-800BW	Q8008RH4	S	TO-220 (N.ISOL)
BTB08-800C	Q8008R5	S	TO-220 (N.ISOL)
BTB08-800CW	Q8008RH4	S	TO-220 (N.ISOL)
BTB10-200B	Q2010R5	S	TO-220 (N.ISOL)
BTB10-200C	Q2010R5	S	TO-220 (N.ISOL)
BTB10-400B	Q4010R5	S	TO-220 (N.ISOL)
BTB10-400BW	Q4010RH5	S	TO-220 (N.ISOL)
BTB10-400C	Q4010R5	S	TO-220 (N.ISOL)
BTB10-400CW	Q4010RH5	S	TO-220 (N.ISOL)
BTB10-600B	Q6010R5	S	TO-220 (N.ISOL)
BTB10-600BW	Q6010RH5	S	TO-220 (N.ISOL)
BTB10-600C	Q6010R5	S	TO-220 (N.ISOL)
BTB10-600CW	Q6010RH5	S	TO-220 (N.ISOL)
BTB10-700B	Q7010R5	S	TO-220 (N.ISOL)
BTB10-700BW	Q7010RH5	S	TO-220 (N.ISOL)
BTB10-700C	Q7010R5	S	TO-220 (N.ISOL)
BTB10-700CW	Q7010RH5	S	TO-220 (N.ISOL)
BTB10-800B	Q8010R5	S	TO-220 (N.ISOL)
BTB10-800BW	Q8010RH5	S	TO-220 (N.ISOL)
BTB10-800C	Q8010R5	S	TO-220 (N.ISOL)
BTB10-800CW	Q8010RH5	S	TO-220 (N.ISOL)
BTB12-200B	Q2015R5	S	TO-220 (N.ISOL)
BTB12-200C	Q2015R5	S	TO-220 (N.ISOL)
BTB12-400B	Q4015R5	S	TO-220 (N.ISOL)
BTB12-400BW	Q4012RH5	S	TO-220 (N.ISOL)
BTB12-400C	Q4015R5	S	TO-220 (N.ISOL)
BTB12-400CW	Q4012RH5	S	TO-220 (N.ISOL)
BTB12-600B	Q6015R5	S	TO-220 (N.ISOL)
BTB12-600BW	Q6012RH5	S	TO-220 (N.ISOL)
BTB12-600C	Q6015R5	S	TO-220 (N.ISOL)
BTB12-600CW	Q6012RH5	S	TO-220 (N.ISOL)
BTB12-700B	Q7015R5	S	TO-220 (N.ISOL)
BTB12-700BW	Q7012RH5	S	TO-220 (N.ISOL)
BTB12-700C	Q7015R5	S	TO-220 (N.ISOL)
BTB12-700CW	Q7012RH5	S	TO-220 (N.ISOL)
BTB12-800B	Q8015R5	S	TO-220 (N.ISOL)
BTB12-800BW	Q8012RH5	S	TO-220 (N.ISOL)
BTB12-800C	Q8015R5	S	TO-220 (N.ISOL)
BTB12-800CW	Q8012RH5	S	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BTB13-200B	Q2015R5	S	TO-220 (N.ISOL)
BTB13-400B	Q4015R5	S	TO-220 (N.ISOL)
BTB13-600B	Q6015R5	S	TO-220 (N.ISOL)
BTB13-700B	Q7015R5	S	TO-220 (N.ISOL)
BTB13-800B	Q8015R5	S	TO-220 (N.ISOL)
BTB15-200B	Q2015R5	S	TO-220 (N.ISOL)
BTB15-400B	Q4015R5	S	TO-220 (N.ISOL)
BTB15-600B	Q5015R5	S	TO-220 (N.ISOL)
BTB15-700B	Q6015R5	S	TO-220 (N.ISOL)
BTB16-200B	Q2015R5	S	TO-220 (N.ISOL)
BTB16-400B	Q4015R5	S	TO-220 (N.ISOL)
BTB16-600B	Q6015R5	S	TO-220 (N.ISOL)
BTB16-700B	Q7015R5	S	TO-220 (N.ISOL)
BTB19-200B	Q2025R5	S	TO-220 (N.ISOL)
BTB19-400B	Q4025R5	S	TO-220 (N.ISOL)
BTB19-600B	Q6025R5	S	TO-220 (N.ISOL)
BTB19-700B	Q7025R5	S	TO-220 (N.ISOL)
BTB20-400BW	Q4025R6	S	TO-220 (N.ISOL)
BTB20-600BW	Q6025R6	S	TO-220 (N.ISOL)
BTB20-700BW	Q7025R6	S	TO-220 (N.ISOL)
BTB20-800BW	Q8025R6	S	TO-220 (N.ISOL)
BTB24-200B	Q2025R5	S	TO-220 (N.ISOL)
BTB24-400B	Q4025R5	S	TO-220 (N.ISOL)
BTB24-600B	Q6025R5	S	TO-220 (N.ISOL)
BTB24-700B	Q7025R5	S	TO-220 (N.ISOL)
BTB24-800B	Q8025R5	S	TO-220 (N.ISOL)
BTB26-200A	Q2025K6	S	TO-218 (ISOL)
BTB26-200B	Q2025K6	S	TO-218 (ISOL)
BTB26-400A	Q4025K6	S	TO-218 (ISOL)
BTB26-400B	Q4025K6	S	TO-218 (ISOL)
BTB26-600A	Q6025K6	S	TO-218 (ISOL)
BTB26-600B	Q6025K6	S	TO-218 (ISOL)
BTB26-700A	Q7025K6	S	TO-218 (ISOL)
BTB26-700B	Q7025K6	S	TO-218 (ISOL)
BTB41-200A	Q2040K7	S	TO-218 (ISOL)
BTB41-200B	Q2040K7	S	TO-218 (ISOL)
BTB41-400A	Q4040K7	S	TO-218 (ISOL)
BTB41-400B	Q4040K7	S	TO-218 (ISOL)
BTB41-600A	Q6040K7	S	TO-218 (ISOL)
BTB41-600B	Q6040K7	S	TO-218 (ISOL)
BTB41-700A	Q7040K7	S	TO-218 (ISOL)
BTB41-700B	Q7040K7	S	TO-218 (ISOL)
BTW41-500G	Q5040P	S	FASTPAK (ISOL)
BTW41-600G	Q6040P	S	FASTPAK (ISOL)
BTW66-200	S2035J	S	TO-218 (ISOL)
BTW66-400	S4035J	S	TO-218 (ISOL)
BTW66-600	S6035J	S	TO-218 (ISOL)
BTW66-800	S8035J	S	TO-218 (ISOL)
BTW67-200	S2065J	S	TO-218 (ISOL)
BTW67-400	S4065J	S	TO-218 (ISOL)
BTW67-600	S6065J	S	TO-218 (ISOL)
BTW67-800	S8065J	S	TO-218 (ISOL)
BTW68-200	S2035K	D	TO-218 (ISOL)
BTW68-200N	S2035K	S	TO-218 (ISOL)
BTW68-400	S4035K	D	TO-218 (ISOL)
BTW68-400N	S4035K	S	TO-218 (ISOL)
BTW68-600	S6035K	D	TO-218 (ISOL)
BTW68-600N	S6035K	S	TO-218 (ISOL)
BTW68-800	S8035K	D	TO-218 (ISOL)
BTW68-800N	S8035K	S	TO-218 (ISOL)
BTW69-200	S2065K	D	TO-218 (ISOL)
BTW69-200N	S2055M	D	TO-218 (N.ISOL)
BTW69-400	S4065K	D	TO-218 (ISOL)
BTW69-400N	S4055M	D	TO-218 (N.ISOL)
BTW69-600	S6065K	D	TO-218 (ISOL)
BTW69-600N	S6055M	D	TO-218 (N.ISOL)
BTW69-800	S8065K	D	TO-218 (ISOL)
BTW69-800N	S8055M	D	TO-218 (N.ISOL)
BTW70-200N	S2070W	S	TO-218 (N.ISOL)
BTW70-400N	S4070W	S	TO-218 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
BTW70-600N	S6070W	S	TO-218 (N.ISOL)
BYW80-100	D2020L	S	TO-220 (ISOL)
BYW80-150	D2020L	S	TO-220 (ISOL)
BYW80-200	D2020L	S	TO-220 (ISOL)
BYW80-50	D0520L	S	TO-220 (ISOL)
C103A	EC103A	S	TO-92 (ISOL)
C103B	EC103B	S	TO-92 (ISOL)
C103D	EC103D	S	TO-92 (ISOL)
C103E	EC103E	S	TO-92 (ISOL)
C103M	EC103M	S	TO-92 (ISOL)
C103Y	EC103A	S	TO-92 (ISOL)
C103YY	EC103A	S	TO-92 (ISOL)
C106A	T106A1	S	TO-202 (N.ISOL)
C106A1	T106A1	S	TO-202 (N.ISOL)
C106A11	T106A11	S	TO-202 (N.ISOL)
C106A12	T106A12	S	TO-202 (N.ISOL)
C106A2	T106A2	S	TO-202 (N.ISOL)
C106A21	T106A21	S	TO-202 (N.ISOL)
C106A3	T106A3	S	TO-202 (N.ISOL)
C106A32	T106A32	S	TO-202 (N.ISOL)
C106A4	T106A4	S	TO-202 (N.ISOL)
C106A41	T106A41	S	TO-202 (N.ISOL)
C106B	T106B1	S	TO-202 (N.ISOL)
C106B1	T106B1	S	TO-202 (N.ISOL)
C106B11	T106B11	S	TO-202 (N.ISOL)
C106B12	T106B12	S	TO-202 (N.ISOL)
C106B2	T106B2	S	TO-202 (N.ISOL)
C106B21	T106B21	S	TO-202 (N.ISOL)
C106B3	T106B3	S	TO-202 (N.ISOL)
C106B32	T106B32	S	TO-202 (N.ISOL)
C106B4	T106B4	S	TO-202 (N.ISOL)
C106B41	T106B41	S	TO-202 (N.ISOL)
C106C	T106C	S	TO-202 (N.ISOL)
C106C1	T106C1	S	TO-202 (N.ISOL)
C106C11	T106C11	S	TO-202 (N.ISOL)
C106C12	T106C12	S	TO-202 (N.ISOL)
C106C2	T106C2	S	TO-202 (N.ISOL)
C106C21	T106C21	S	TO-202 (N.ISOL)
C106C3	T106C3	S	TO-202 (N.ISOL)
C106C32	T106C32	S	TO-202 (N.ISOL)
C106C4	T106C4	S	TO-202 (N.ISOL)
C106C41	T106C41	S	TO-202 (N.ISOL)
C106D	T106D1	S	TO-202 (N.ISOL)
C106D1	T106D1	S	TO-202 (N.ISOL)
C106D11	T106D11	S	TO-202 (N.ISOL)
C106D12	T106D12	S	TO-202 (N.ISOL)
C106D2	T106D2	S	TO-202 (N.ISOL)
C106D21	T106D21	S	TO-202 (N.ISOL)
C106D3	T106D3	S	TO-202 (N.ISOL)
C106D32	T106D32	S	TO-202 (N.ISOL)
C106D4	T106D4	S	TO-202 (N.ISOL)
C106D41	T106D41	S	TO-202 (N.ISOL)
C106E	T106E1	S	TO-202 (N.ISOL)
C106E1	T106E1	S	TO-202 (N.ISOL)
C106E11	T106E11	S	TO-202 (N.ISOL)
C106E12	T106E12	S	TO-202 (N.ISOL)
C106E2	T106E2	S	TO-202 (N.ISOL)
C106E21	T106E21	S	TO-202 (N.ISOL)
C106E3	T106E3	S	TO-202 (N.ISOL)
C106E32	T106E32	S	TO-202 (N.ISOL)
C106E4	T106E4	S	TO-202 (N.ISOL)
C106E41	T106E41	S	TO-202 (N.ISOL)
C106F	T106F1	S	TO-202 (N.ISOL)
C106F1	T106F1	S	TO-202 (N.ISOL)
C106F11	T106F11	S	TO-202 (N.ISOL)
C106F12	T106F12	S	TO-202 (N.ISOL)
C106F2	T106F2	S	TO-202 (N.ISOL)
C106F21	T106F21	S	TO-202 (N.ISOL)
C106F3	T106F3	S	TO-202 (N.ISOL)
C106F32	T106F32	S	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
C106F4	T106F4	S	TO-202 (N.ISOL)
C106F41	T106F41	S	TO-202 (N.ISOL)
C106M	T106M1	S	TO-202 (N.ISOL)
C106M1	T106M1	S	TO-202 (N.ISOL)
C106M11	T106M11	S	TO-202 (N.ISOL)
C106M12	T106M12	S	TO-202 (N.ISOL)
C106M2	T106M2	S	TO-202 (N.ISOL)
C106M21	T106M21	S	TO-202 (N.ISOL)
C106M3	T106M3	S	TO-202 (N.ISOL)
C106M32	T106M32	S	TO-202 (N.ISOL)
C106M4	T106M4	S	TO-202 (N.ISOL)
C106M41	T106M41	S	TO-202 (N.ISOL)
C106Q	T106F1	S	TO-202 (N.ISOL)
C106Q1	T106F1	S	TO-202 (N.ISOL)
C106Q11	T106F11	S	TO-202 (N.ISOL)
C106Q12	T106F12	S	TO-202 (N.ISOL)
C106Q2	T106F2	S	TO-202 (N.ISOL)
C106Q21	T106F21	S	TO-202 (N.ISOL)
C106Q3	T106F3	S	TO-202 (N.ISOL)
C106Q32	T106F32	S	TO-202 (N.ISOL)
C106Q4	T106F4	S	TO-202 (N.ISOL)
C106Q41	T106F41	S	TO-202 (N.ISOL)
C106Y	T106F1	S	TO-202 (N.ISOL)
C106Y1	T106F1	S	TO-202 (N.ISOL)
C106Y11	T106F11	S	TO-202 (N.ISOL)
C106Y12	T106F12	S	TO-202 (N.ISOL)
C106Y2	T106F2	S	TO-202 (N.ISOL)
C106Y21	T106F21	S	TO-202 (N.ISOL)
C106Y3	T106F3	S	TO-202 (N.ISOL)
C106Y32	T106F32	S	TO-202 (N.ISOL)
C106Y4	T106F4	S	TO-202 (N.ISOL)
C106Y41	T106F41	S	TO-202 (N.ISOL)
C107A	T107A1	S	TO-202 (N.ISOL)
C107A1	T107A1	S	TO-202 (N.ISOL)
C107A11	T107A11	S	TO-202 (N.ISOL)
C107A12	T107A12	S	TO-202 (N.ISOL)
C107A2	T107A2	S	TO-202 (N.ISOL)
C107A21	T107A21	S	TO-202 (N.ISOL)
C107A3	T107A3	S	TO-202 (N.ISOL)
C107A32	T107A32	S	TO-202 (N.ISOL)
C107A4	T107A4	S	TO-202 (N.ISOL)
C107A41	T107A41	S	TO-202 (N.ISOL)
C107B	T107B1	S	TO-202 (N.ISOL)
C107B1	T107B1	S	TO-202 (N.ISOL)
C107B11	T107B11	S	TO-202 (N.ISOL)
C107B12	T107B12	S	TO-202 (N.ISOL)
C107B2	T107B2	S	TO-202 (N.ISOL)
C107B21	T107B21	S	TO-202 (N.ISOL)
C107B3	T107B3	S	TO-202 (N.ISOL)
C107B32	T107B32	S	TO-202 (N.ISOL)
C107B4	T107B4	S	TO-202 (N.ISOL)
C107B41	T107B41	S	TO-202 (N.ISOL)
C107C	T107C1	S	TO-202 (N.ISOL)
C107C1	T107C1	S	TO-202 (N.ISOL)
C107C11	T107C11	S	TO-202 (N.ISOL)
C107C12	T107C12	S	TO-202 (N.ISOL)
C107C2	T107C2	S	TO-202 (N.ISOL)
C107C21	T107C21	S	TO-202 (N.ISOL)
C107C3	T107C3	S	TO-202 (N.ISOL)
C107C32	T107C32	S	TO-202 (N.ISOL)
C107C4	T107C4	S	TO-202 (N.ISOL)
C107C41	T107C41	S	TO-202 (N.ISOL)
C107D	T107D1	S	TO-202 (N.ISOL)
C107D1	T107D1	S	TO-202 (N.ISOL)
C107D11	T107D11	S	TO-202 (N.ISOL)
C107D12	T107D12	S	TO-202 (N.ISOL)
C107D2	T107D2	S	TO-202 (N.ISOL)
C107D21	T107D21	S	TO-202 (N.ISOL)
C107D3	T107D3	S	TO-202 (N.ISOL)
C107D32	T107D32	S	TO-202 (N.ISOL)

Cross Reference Guide

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
C107D4	T107D4	S	TO-202 (N.ISOL)
C107D41	T107D41	S	TO-202 (N.ISOL)
C107E	T107E1	S	TO-202 (N.ISOL)
C107E1	T107E1	S	TO-202 (N.ISOL)
C107E11	T107E11	S	TO-202 (N.ISOL)
C107E12	T107E12	S	TO-202 (N.ISOL)
C107E2	T107E2	S	TO-202 (N.ISOL)
C107E21	T107E21	S	TO-202 (N.ISOL)
C107E3	T107E3	S	TO-202 (N.ISOL)
C107E32	T107E32	S	TO-202 (N.ISOL)
C107E4	T107E4	S	TO-202 (N.ISOL)
C107E41	T107E41	S	TO-202 (N.ISOL)
C107F	T107F1	S	TO-202 (N.ISOL)
C107F1	T107F1	S	TO-202 (N.ISOL)
C107F11	T107F11	S	TO-202 (N.ISOL)
C107F12	T107F12	S	TO-202 (N.ISOL)
C107F2	T107F2	S	TO-202 (N.ISOL)
C107F21	T107F21	S	TO-202 (N.ISOL)
C107F3	T107F3	S	TO-202 (N.ISOL)
C107F32	T107F32	S	TO-202 (N.ISOL)
C107F4	T107F4	S	TO-202 (N.ISOL)
C107F41	T107F41	S	TO-202 (N.ISOL)
C107M	T107M1	S	TO-202 (N.ISOL)
C107M1	T107M1	S	TO-202 (N.ISOL)
C107M11	T107M11	S	TO-202 (N.ISOL)
C107M12	T107M12	S	TO-202 (N.ISOL)
C107M2	T107M2	S	TO-202 (N.ISOL)
C107M21	T107M21	S	TO-202 (N.ISOL)
C107M3	T107M3	S	TO-202 (N.ISOL)
C107M32	T107M32	S	TO-202 (N.ISOL)
C107M41	T107M41	S	TO-202 (N.ISOL)
C107Q	T107F1	S	TO-202 (N.ISOL)
C107Q1	T107F1	S	TO-202 (N.ISOL)
C107Q11	T107F11	S	TO-202 (N.ISOL)
C107Q12	T107F12	S	TO-202 (N.ISOL)
C107Q2	T107F2	S	TO-202 (N.ISOL)
C107Q21	T107F21	S	TO-202 (N.ISOL)
C107Q3	T107F3	S	TO-202 (N.ISOL)
C107Q32	T107F32	S	TO-202 (N.ISOL)
C107Q4	T107F4	S	TO-202 (N.ISOL)
C107Q41	T107F41	S	TO-202 (N.ISOL)
C107Y	T107F1	S	TO-202 (N.ISOL)
C107Y1	T107F1	S	TO-202 (N.ISOL)
C107Y11	T107F11	S	TO-202 (N.ISOL)
C107Y12	T107F12	S	TO-202 (N.ISOL)
C107Y2	T107F2	S	TO-202 (N.ISOL)
C107Y21	T107F21	S	TO-202 (N.ISOL)
C107Y3	T107F3	S	TO-202 (N.ISOL)
C107Y32	T107F32	S	TO-202 (N.ISOL)
C107Y4	T107F4	S	TO-202 (N.ISOL)
C107Y41	T107F41	S	TO-202 (N.ISOL)
C108A	S1006FS21	S	TO-202 (N.ISOL)
C108A1	S1006FS21	S	TO-202 (N.ISOL)
C108A11	S1006FS211	S	TO-202 (N.ISOL)
C108A12	S1006FS212	S	TO-202 (N.ISOL)
C108A2	S1006FS22	S	TO-202 (N.ISOL)
C108A21	S1006FS221	S	TO-202 (N.ISOL)
C108A3	S1006FS23	S	TO-202 (N.ISOL)
C108A32	S1006FS232	S	TO-202 (N.ISOL)
C108A4	S1006FS24	S	TO-202 (N.ISOL)
C108A41	S1006FS241	S	TO-202 (N.ISOL)
C108B	S2006FS21	S	TO-202 (N.ISOL)
C108B1	S2006FS21	S	TO-202 (N.ISOL)
C108B11	S2006FS211	S	TO-202 (N.ISOL)
C108B12	S2006FS212	S	TO-202 (N.ISOL)
C108B2	S2006FS22	S	TO-202 (N.ISOL)
C108B21	S2006FS221	S	TO-202 (N.ISOL)
C108B3	S2006FS23	S	TO-202 (N.ISOL)
C108B32	S2006FS232	S	TO-202 (N.ISOL)
C108B4	S2006FS24	S	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
C108B41	S2006FS241	S	TO-202 (N.ISOL)
C108C	S4006FS21	S	TO-202 (N.ISOL)
C108C1	S4006FS21	S	TO-202 (N.ISOL)
C108C11	S4006FS211	S	TO-202 (N.ISOL)
C108C12	S4006FS212	S	TO-202 (N.ISOL)
C108C2	S4006FS22	S	TO-202 (N.ISOL)
C108C21	S4006FS221	S	TO-202 (N.ISOL)
C108C3	S4006FS23	S	TO-202 (N.ISOL)
C108C32	S4006FS232	S	TO-202 (N.ISOL)
C108C4	S4006FS24	S	TO-202 (N.ISOL)
C108C41	S4006FS241	S	TO-202 (N.ISOL)
C108D	S4006FS21	S	TO-202 (N.ISOL)
C108D1	S4006FS21	S	TO-202 (N.ISOL)
C108D11	S4006FS211	S	TO-202 (N.ISOL)
C108D12	S4006FS212	S	TO-202 (N.ISOL)
C108D2	S4006FS22	S	TO-202 (N.ISOL)
C108D21	S4006FS221	S	TO-202 (N.ISOL)
C108D3	S4006FS23	S	TO-202 (N.ISOL)
C108D32	S4006FS232	S	TO-202 (N.ISOL)
C108D4	S4006FS24	S	TO-202 (N.ISOL)
C108D41	S4006FS241	S	TO-202 (N.ISOL)
C108E	S6006FS21	S	TO-202 (N.ISOL)
C108E1	S6006FS21	S	TO-202 (N.ISOL)
C108E11	S6006FS211	S	TO-202 (N.ISOL)
C108E12	S6006FS212	S	TO-202 (N.ISOL)
C108E2	S6006FS22	S	TO-202 (N.ISOL)
C108E21	S6006FS221	S	TO-202 (N.ISOL)
C108E3	S6006FS23	S	TO-202 (N.ISOL)
C108E32	S6006FS232	S	TO-202 (N.ISOL)
C108E4	S6006FS24	S	TO-202 (N.ISOL)
C108E41	S6006FS241	S	TO-202 (N.ISOL)
C108F	S0506FS21	S	TO-202 (N.ISOL)
C108F1	S0506FS21	S	TO-202 (N.ISOL)
C108F11	S0506FS211	S	TO-202 (N.ISOL)
C108F12	S0506FS212	S	TO-202 (N.ISOL)
C108F2	S0506FS22	S	TO-202 (N.ISOL)
C108F21	S0506FS221	S	TO-202 (N.ISOL)
C108F3	S0506FS23	S	TO-202 (N.ISOL)
C108F32	S0506FS232	S	TO-202 (N.ISOL)
C108F4	S0506FS24	S	TO-202 (N.ISOL)
C108F41	S0506FS241	S	TO-202 (N.ISOL)
C108M	S6006FS21	S	TO-202 (N.ISOL)
C108M1	S6006FS21	S	TO-202 (N.ISOL)
C108M11	S6006FS211	S	TO-202 (N.ISOL)
C108M12	S6006FS212	S	TO-202 (N.ISOL)
C108M2	S6006FS22	S	TO-202 (N.ISOL)
C108M21	S6006FS221	S	TO-202 (N.ISOL)
C108M3	S6006FS23	S	TO-202 (N.ISOL)
C108M32	S6006FS232	S	TO-202 (N.ISOL)
C108M4	S6006FS24	S	TO-202 (N.ISOL)
C108M41	S6006FS241	S	TO-202 (N.ISOL)
C108Q	S0506FS21	S	TO-202 (N.ISOL)
C108Q1	S0506FS21	S	TO-202 (N.ISOL)
C108Q11	S0506FS211	S	TO-202 (N.ISOL)
C108Q12	S0506FS212	S	TO-202 (N.ISOL)
C108Q2	S0506FS22	S	TO-202 (N.ISOL)
C108Q21	S0506FS221	S	TO-202 (N.ISOL)
C108Q3	S0506FS23	S	TO-202 (N.ISOL)
C108Q32	S0506FS232	S	TO-202 (N.ISOL)
C108Q4	S0506FS24	S	TO-202 (N.ISOL)
C108Q41	S0506FS241	S	TO-202 (N.ISOL)
C108Y	S0506FS21	S	TO-202 (N.ISOL)
C108Y1	S0506FS21	S	TO-202 (N.ISOL)
C108Y11	S0506FS211	S	TO-202 (N.ISOL)
C108Y12	S0506FS212	S	TO-202 (N.ISOL)
C108Y2	S0506FS22	S	TO-202 (N.ISOL)
C108Y21	S0506FS221	S	TO-202 (N.ISOL)
C108Y3	S0506FS23	S	TO-202 (N.ISOL)
C108Y32	S0506FS232	S	TO-202 (N.ISOL)
C108Y4	S0506FS24	S	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
C108Y41	S0506FS241	S	TO-202 (N.ISOL)
C116A1	S1008F1	S	TO-202 (N.ISOL)
C116B1	S2008F1	S	TO-202 (N.ISOL)
C116C1	S4008F1	S	TO-202 (N.ISOL)
C116D1	S4008F1	S	TO-202 (N.ISOL)
C116E1	S6008F1	S	TO-202 (N.ISOL)
C116F1	S0508F1	S	TO-202 (N.ISOL)
C116M1	S6008F1	S	TO-202 (N.ISOL)
C122A	S1008R	S	TO-220 (N.ISOL)
C122B	S2008R	S	TO-220 (N.ISOL)
C122C	S4008R	S	TO-220 (N.ISOL)
C122D	S4008R	S	TO-220 (N.ISOL)
C122E	S6008R	S	TO-220 (N.ISOL)
C122F	S0508R	S	TO-220 (N.ISOL)
C122M	S6008R	S	TO-220 (N.ISOL)
C122N	S8008R	S	TO-220 (N.ISOL)
C122S	S8008R	S	TO-220 (N.ISOL)
C123A	S1008L	S	TO-220 (ISOL)
C123B	S2008L	S	TO-220 (ISOL)
C123C	S4008L	S	TO-220 (ISOL)
C123D	S4008L	S	TO-220 (ISOL)
C123E	S6008L	S	TO-220 (ISOL)
C123F	S0508L	S	TO-220 (ISOL)
C123M	S6008L	S	TO-220 (ISOL)
C126A	S1012R	S	TO-220 (N.ISOL)
C126B	S2012R	S	TO-220 (N.ISOL)
C126C	S4012R	S	TO-220 (N.ISOL)
C126D	S4012R	S	TO-220 (N.ISOL)
C126E	S6012R	S	TO-220 (N.ISOL)
C126F	S0512R	S	TO-220 (N.ISOL)
C126M	S6012R	S	TO-220 (N.ISOL)
C127A	S1016R	D	TO-220 (N.ISOL)
C127B	S2016R	D	TO-220 (N.ISOL)
C127D	S4016R	D	TO-220 (N.ISOL)
C127E	S6016R	D	TO-220 (N.ISOL)
C127F	S0516R	D	TO-220 (N.ISOL)
C127M	S6016R	D	TO-220 (N.ISOL)
C203A	EC103A	S	TO-92 (ISOL)
C203B	EC103B	S	TO-92 (ISOL)
C203C	EC103C	S	TO-92 (ISOL)
C203D	EC103D	S	TO-92 (ISOL)
C203Y	EC103A	S	TO-92 (ISOL)
C203YY	EC103A	S	TO-92 (ISOL)
C205A	EC103A	D	TO-92 (ISOL)
C205B	EC103B	D	TO-92 (ISOL)
C205C	EC103C	D	TO-92 (ISOL)
C205D	EC103D	D	TO-92 (ISOL)
C205Y	EC103A	D	TO-92 (ISOL)
C205YY	EC103A	D	TO-92 (ISOL)
D30	HT32	D	DO-35 (ISOL)
D40	HT40	D	DO-35 (ISOL)
D60	HT60	D	DO-35 (ISOL)
DB3	HT32	S	DO-35 (ISOL)
DB4	HT40	D	DO-35 (ISOL)
DB6	HT60	D	DO-35 (ISOL)
DC34	HT32	S	DO-35 (ISOL)
DC38	HT40	S	DO-35 (ISOL)
DC42	HT40	S	DO-35 (ISOL)
DO201YR	HT5761	D	DO-35 (ISOL)
E0102AA	EC113A	S	TO-92 (ISOL)
E0102AB	EC113A	S	TO-92 (ISOL)
E0102FA	EC113A	S	TO-92 (ISOL)
E0102FB	EC113A	S	TO-92 (ISOL)
E0102YA	EC113A	S	TO-92 (ISOL)
E0102YB	EC113A	S	TO-92 (ISOL)
HI03SC	L2004F31	S	TO-202 (N.ISOL)
HI03SD	L2004F51	S	TO-202 (N.ISOL)
HI03SG	L2004F61	S	TO-202 (N.ISOL)
HI03SH	L2004F81	S	TO-202 (N.ISOL)
HI03SS	L2004F31	S	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
HI13SC	L2004F31	S	TO-202 (N.ISOL)
HI13SD	L2004F51	S	TO-202 (N.ISOL)
HI13SG	L2004F61	S	TO-202 (N.ISOL)
HI13SH	L2004F81	S	TO-202 (N.ISOL)
HI13SS	L2004F31	S	TO-202 (N.ISOL)
HI23SC	L2004F31	S	TO-202 (N.ISOL)
HI23SD	L2004F51	S	TO-202 (N.ISOL)
HI23SG	L2004F61	S	TO-202 (N.ISOL)
HI23SH	L2004F81	S	TO-202 (N.ISOL)
HI23SS	L2004F31	S	TO-202 (N.ISOL)
HI33SC	L4004F31	S	TO-202 (N.ISOL)
HI33SD	L4004F51	S	TO-202 (N.ISOL)
HI33SG	L4004F61	S	TO-202 (N.ISOL)
HI33SH	L4004F81	S	TO-202 (N.ISOL)
HI33SS	L4004F31	S	TO-202 (N.ISOL)
HI43SC	L4004F31	S	TO-202 (N.ISOL)
HI43SD	L4004F51	S	TO-202 (N.ISOL)
HI43SG	L4004F61	S	TO-202 (N.ISOL)
HI43SH	L4004F81	S	TO-202 (N.ISOL)
HI43SS	L4004F31	S	TO-202 (N.ISOL)
HI63SC	L6004F31	S	TO-202 (N.ISOL)
HI63SD	L6004F51	S	TO-202 (N.ISOL)
HI63SG	L6004F61	S	TO-202 (N.ISOL)
HI63SH	L6004F81	S	TO-202 (N.ISOL)
HI63SS	L6004F31	S	TO-202 (N.ISOL)
HT06	Q2006F41	S	TO-202 (N.ISOL)
HT16	Q2006F41	S	TO-202 (N.ISOL)
HT26	Q2006F41	S	TO-202 (N.ISOL)
HT36	Q4006F41	S	TO-202 (N.ISOL)
HT46	Q4006F41	S	TO-202 (N.ISOL)
HT66	Q6006F41	S	TO-202 (N.ISOL)
ID100	EC103A	S	TO-92 (ISOL)
ID101	EC103A	S	TO-92 (ISOL)
ID102	EC103A	S	TO-92 (ISOL)
ID103	EC103B	S	TO-92 (ISOL)
ID104	EC103B	S	TO-92 (ISOL)
ID105	EC103C	S	TO-92 (ISOL)
ID106	EC103D	S	TO-92 (ISOL)
IP100	2N5060	D	TO-92 (ISOL)
IP101	2N5061	D	TO-92 (ISOL)
IP102	2N5062	D	TO-92 (ISOL)
IP103	2N5063	D	TO-92 (ISOL)
IP104	2N5064	D	TO-92 (ISOL)
IP105	EC103C	D	TO-92 (ISOL)
IP106	EC103D	D	TO-92 (ISOL)
IS010	S0510L	D	TO-220 (ISOL)
IS010X	S0510L	D	TO-220 (ISOL)
IS020	S0520L	S	TO-220 (ISOL)
IS020X	S0520L	D	TO-220 (ISOL)
IS08	S0508L	D	TO-220 (ISOL)
IS08X	S0508L	D	TO-220 (ISOL)
IS110	S1010L	D	TO-220 (ISOL)
IS110X	S1010L	D	TO-220 (ISOL)
IS120	S1020L	S	TO-220 (ISOL)
IS120X	S1020L	D	TO-220 (ISOL)
IS18	S1008L	D	TO-220 (ISOL)
IS18X	S1008L	D	TO-220 (ISOL)
IS210	S2010L	D	TO-220 (ISOL)
IS210X	S2010L	D	TO-220 (ISOL)
IS220	S2020L	S	TO-220 (ISOL)
IS220X	S2020L	D	TO-220 (ISOL)
IS28	S2008L	D	TO-220 (ISOL)
IS28X	S2008L	D	TO-220 (ISOL)
IS310	S4010L	D	TO-220 (ISOL)
IS310X	S4010L	D	TO-220 (ISOL)
IS320	S4020L	S	TO-220 (ISOL)
IS320X	S4020L	D	TO-220 (ISOL)
IS38	S4008L	D	TO-220 (ISOL)
IS38X	S4008L	D	TO-220 (ISOL)
IS410	S4010L	D	TO-220 (ISOL)

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Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
IS410X	S4010L	D	TO-220 (ISOL)
IS420	S4020L	S	TO-220 (ISOL)
IS420X	S4020L	D	TO-220 (ISOL)
IS48	S4008L	D	TO-220 (ISOL)
IS48X	S4008L	D	TO-220 (ISOL)
IS510	S6010L	D	TO-220 (ISOL)
IS510X	S6010L	D	TO-220 (ISOL)
IS520	S6020L	S	TO-220 (ISOL)
IS520X	S6020L	D	TO-220 (ISOL)
IS58	S6008L	D	TO-220 (ISOL)
IS58X	S6008L	D	TO-220 (ISOL)
IS610	S6010L	D	TO-220 (ISOL)
IS610X	S6010L	D	TO-220 (ISOL)
IS620	S6020L	S	TO-220 (ISOL)
IS620X	S6020L	D	TO-220 (ISOL)
IS68	S6008L	D	TO-220 (ISOL)
IS68X	S6008L	D	TO-220 (ISOL)
IT010	Q2010L5	D	TO-220 (ISOL)
IT010A	Q2010L5	D	TO-220 (ISOL)
IT010B	Q2010L5	D	TO-220 (ISOL)
IT010HA	Q2010L5	S	TO-220 (ISOL)
IT010HX	Q2010L5	S	TO-220 (ISOL)
IT015	Q2015L5	D	TO-220 (ISOL)
IT015A	Q2015L5	D	TO-220 (ISOL)
IT015B	Q2015L5	D	TO-220 (ISOL)
IT015HA	Q2015L5	S	TO-220 (ISOL)
IT015HX	Q2015L5	S	TO-220 (ISOL)
IT06	Q2006L4	D	TO-220 (ISOL)
IT08	Q2008L4	D	TO-220 (ISOL)
IT08A	Q2008L4	D	TO-220 (ISOL)
IT08B	Q2008L4	D	TO-220 (ISOL)
IT08HA	Q2008L4	D	TO-220 (ISOL)
IT08HX	Q2008L4	S	TO-220 (ISOL)
IT110	Q2010L5	D	TO-220 (ISOL)
IT110A	Q2010L5	D	TO-220 (ISOL)
IT110B	Q2010L5	D	TO-220 (ISOL)
IT110HA	Q2010L5	S	TO-220 (ISOL)
IT110HX	Q2010L5	S	TO-220 (ISOL)
IT115	Q2015L5	D	TO-220 (ISOL)
IT115A	Q2015L5	D	TO-220 (ISOL)
IT115B	Q2015L5	D	TO-220 (ISOL)
IT115HA	Q2015L5	S	TO-220 (ISOL)
IT115HX	Q2015L5	S	TO-220 (ISOL)
IT16	Q2006L4	D	TO-220 (ISOL)
IT18	Q2008L4	D	TO-220 (ISOL)
IT18A	Q2008L4	D	TO-220 (ISOL)
IT18B	Q2008L4	D	TO-220 (ISOL)
IT18HA	Q2008L4	D	TO-220 (ISOL)
IT18HX	Q2008L4	S	TO-220 (ISOL)
IT210	Q2010L5	D	TO-220 (ISOL)
IT210A	Q2010L5	D	TO-220 (ISOL)
IT210B	Q2010L5	D	TO-220 (ISOL)
IT210HA	Q2010L5	S	TO-220 (ISOL)
IT210HX	Q2010L5	S	TO-220 (ISOL)
IT215	Q2015L5	D	TO-220 (ISOL)
IT215A	Q2015L5	D	TO-220 (ISOL)
IT215B	Q2015L5	D	TO-220 (ISOL)
IT215HA	Q2015L5	S	TO-220 (ISOL)
IT215HX	Q2015L5	S	TO-220 (ISOL)
IT26	Q2006L4	D	TO-220 (ISOL)
IT28	Q2008L4	D	TO-220 (ISOL)
IT28A	Q2008L4	D	TO-220 (ISOL)
IT28B	Q2008L4	D	TO-220 (ISOL)
IT28HA	Q2008L4	D	TO-220 (ISOL)
IT28HX	Q2008L4	S	TO-220 (ISOL)
IT310	Q4010L5	D	TO-220 (ISOL)
IT310A	Q4010L5	D	TO-220 (ISOL)
IT310B	Q4010L5	D	TO-220 (ISOL)
IT310HA	Q4010L5	S	TO-220 (ISOL)
IT310HX	Q4010L5	S	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
IT315	Q4015L5	D	TO-220 (ISOL)
IT315A	Q4015L5	D	TO-220 (ISOL)
IT315B	Q4015L5	D	TO-220 (ISOL)
IT315HA	Q4015L5	S	TO-220 (ISOL)
IT315HX	Q4015L5	S	TO-220 (ISOL)
IT36	Q4006L4	D	TO-220 (ISOL)
IT38	Q4008L4	D	TO-220 (ISOL)
IT38A	Q4008L4	D	TO-220 (ISOL)
IT38B	Q4008L4	D	TO-220 (ISOL)
IT38HA	Q4008L4	D	TO-220 (ISOL)
IT38HX	Q4008L4	S	TO-220 (ISOL)
IT410	Q4010L5	D	TO-220 (ISOL)
IT410A	Q4010L5	D	TO-220 (ISOL)
IT410B	Q4010L5	D	TO-220 (ISOL)
IT410HA	Q4010L5	S	TO-220 (ISOL)
IT410HX	Q4010L5	S	TO-220 (ISOL)
IT415	Q4015L5	D	TO-220 (ISOL)
IT415A	Q4015L5	D	TO-220 (ISOL)
IT415B	Q4015L5	D	TO-220 (ISOL)
IT415HA	Q4015L5	S	TO-220 (ISOL)
IT415HX	Q4015L5	S	TO-220 (ISOL)
IT46	Q4006L4	D	TO-220 (ISOL)
IT48	Q4008L4	D	TO-220 (ISOL)
IT48A	Q4008L4	D	TO-220 (ISOL)
IT48B	Q4008L4	D	TO-220 (ISOL)
IT48HA	Q4008L4	D	TO-220 (ISOL)
IT48HX	Q4008L4	S	TO-220 (ISOL)
IT510	Q5010L5	D	TO-220 (ISOL)
IT510A	Q5010L5	D	TO-220 (ISOL)
IT510B	Q5010L5	D	TO-220 (ISOL)
IT510HA	Q5010L5	S	TO-220 (ISOL)
IT510HX	Q5010L5	S	TO-220 (ISOL)
IT515	Q5015L5	D	TO-220 (ISOL)
IT515A	Q5015L5	D	TO-220 (ISOL)
IT515B	Q5015L5	D	TO-220 (ISOL)
IT515HA	Q5015L5	S	TO-220 (ISOL)
IT515HX	Q5015L5	S	TO-220 (ISOL)
IT56	Q5006L4	D	TO-220 (ISOL)
IT58	Q5008L4	D	TO-220 (ISOL)
IT58A	Q5008L4	D	TO-220 (ISOL)
IT58B	Q5008L4	D	TO-220 (ISOL)
IT58HA	Q5008L4	D	TO-220 (ISOL)
IT58HX	Q5008L4	S	TO-220 (ISOL)
IT610	Q6010L5	D	TO-220 (ISOL)
IT610A	Q6010L5	D	TO-220 (ISOL)
IT610B	Q6010L5	D	TO-220 (ISOL)
IT610HA	Q6010L5	S	TO-220 (ISOL)
IT610HX	Q6010L5	S	TO-220 (ISOL)
IT615	Q6015L5	D	TO-220 (ISOL)
IT615A	Q6015L5	D	TO-220 (ISOL)
IT615B	Q6015L5	D	TO-220 (ISOL)
IT615HA	Q6015L5	S	TO-220 (ISOL)
IT615HX	Q6015L5	S	TO-220 (ISOL)
IT66	Q6006L5	D	TO-220 (ISOL)
IT68	Q6008L5	D	TO-220 (ISOL)
IT68A	Q6008L5	D	TO-220 (ISOL)
IT68B	Q6008L5	D	TO-220 (ISOL)
IT68HA	Q6008L5	S	TO-220 (ISOL)
IT68HX	Q6008L5	S	TO-220 (ISOL)
K1V10	K1050G	S	DO-15X
K1V11	K1100G	S	DO-15X
K1V12	K1200G	S	DO-15X
K1V14	K1300G	S	DO-15X
K1V16	K1500G	S	DO-15X
K1V18	K1500G	S	DO-15X
K1V22	K2200G	S	DO-15X
K1V24	K2400G	S	DO-15X
K1V24W	K2401F1	S	TO-202 (N.ISOL)
K1V26	K2500G	S	DO-15X
K1VA10	K1050E70	S	TO-92 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
K1VA11	K1100E70	S	TO-92 (ISOL)
K1VA12	K1200E70	S	TO-92 (ISOL)
K1VA14	K1300E70	S	TO-92 (ISOL)
K1VA16	K1500E70	S	TO-92 (ISOL)
MAC15-10	Q8015R5	D	TO-220 (N.ISOL)
MAC15-10FP	Q8015L5	D	TO-220 (ISOL)
MAC15-4	Q2015R5	D	TO-220 (N.ISOL)
MAC15-4FP	Q2015L5	D	TO-220 (ISOL)
MAC15-5	Q4015R5	D	TO-220 (N.ISOL)
MAC15-6	Q4015R5	D	TO-220 (N.ISOL)
MAC15-6FP	Q4015L5	D	TO-220 (ISOL)
MAC15-7	Q5015R5	D	TO-220 (N.ISOL)
MAC15-8	Q6015R5	D	TO-220 (N.ISOL)
MAC15-8FP	Q6015L5	D	TO-220 (ISOL)
MAC15-9	Q7015R5	D	TO-220 (N.ISOL)
MAC15A10	Q8015R5	S	TO-220 (N.ISOL)
MAC15A10FP	Q8015L5	S	TO-220 (ISOL)
MAC15A4	Q2015R5	S	TO-220 (N.ISOL)
MAC15A4FP	Q2015L5	S	TO-220 (ISOL)
MAC15A5	Q4015R5	S	TO-220 (N.ISOL)
MAC15A5FP	Q4015L5	S	TO-220 (ISOL)
MAC15A6	Q4015R5	S	TO-220 (N.ISOL)
MAC15A6FP	Q4015L5	S	TO-220 (ISOL)
MAC15A7	Q5015R5	S	TO-220 (N.ISOL)
MAC15A7FP	Q5015L5	S	TO-220 (ISOL)
MAC15A8	Q6015R5	S	TO-220 (N.ISOL)
MAC15A8FP	Q6015L5	S	TO-220 (ISOL)
MAC15A9	Q7015R5	S	TO-220 (N.ISOL)
MAC15A9FP	Q7015L5	S	TO-220 (ISOL)
MAC16-10	Q8015R6	D	TO-220 (N.ISOL)
MAC16-4	Q2015R6	D	TO-220 (N.ISOL)
MAC16-6	Q4015R6	D	TO-220 (N.ISOL)
MAC16-8	Q6015R6	D	TO-220 (N.ISOL)
MAC16D	Q4015R6	S	TO-220 (N.ISOL)
MAC16M	Q6015R6	S	TO-220 (N.ISOL)
MAC16N	Q8015R6	S	TO-220 (N.ISOL)
MAC20-10	Q8025P	S	FASTPAK (ISOL)
MAC20-4	Q2025P	S	FASTPAK (ISOL)
MAC20-5	Q4025P	S	FASTPAK (ISOL)
MAC20-6	Q4025P	S	FASTPAK (ISOL)
MAC20-7	Q5025P	S	FASTPAK (ISOL)
MAC20-8	Q6025P	S	FASTPAK (ISOL)
MAC20-9	Q7025P	S	FASTPAK (ISOL)
MAC20A10	Q8025P	S	FASTPAK (ISOL)
MAC20A4	Q2025P	S	FASTPAK (ISOL)
MAC20A5	Q4025P	S	FASTPAK (ISOL)
MAC20A6	Q4025P	S	FASTPAK (ISOL)
MAC20A7	Q5025P	S	FASTPAK (ISOL)
MAC20A8	Q6025P	S	FASTPAK (ISOL)
MAC20A9	Q7025P	S	FASTPAK (ISOL)
MAC210-10	Q8010R5	D	TO-220 (N.ISOL)
MAC210-10FP	Q8010L5	D	TO-220 (ISOL)
MAC210-4	Q2010R5	D	TO-220 (N.ISOL)
MAC210-4FP	Q2010L5	D	TO-220 (ISOL)
MAC210-5	Q4010R5	D	TO-220 (N.ISOL)
MAC210-6	Q4010R5	D	TO-220 (N.ISOL)
MAC210-6FP	Q4010L5	D	TO-220 (ISOL)
MAC210-7	Q5010R5	D	TO-220 (N.ISOL)
MAC210-8	Q6010R5	D	TO-220 (N.ISOL)
MAC210-8FP	Q6010L5	D	TO-220 (ISOL)
MAC210A10	Q8010R5	S	TO-220 (N.ISOL)
MAC210A10FP	Q8010L5	S	TO-220 (ISOL)
MAC210A4	Q2010R5	S	TO-220 (N.ISOL)
MAC210A4FP	Q2010L5	S	TO-220 (ISOL)
MAC210A5	Q4010R5	S	TO-220 (N.ISOL)
MAC210A5FP	Q4010L5	S	TO-220 (ISOL)
MAC210A6	Q4010R5	S	TO-220 (N.ISOL)
MAC210A6FP	Q4010L5	S	TO-220 (ISOL)
MAC210A7	Q5010R5	S	TO-220 (N.ISOL)
MAC210A7FP	Q5010L5	S	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MAC210A8	Q6010R5	S	TO-220 (N.ISOL)
MAC210A8FP	Q6010L5	S	TO-220 (ISOL)
MAC210A9	Q7010R5	S	TO-220 (N.ISOL)
MAC210A9FP	Q7010L5	S	TO-220 (ISOL)
MAC212-10	Q8012RH5	D	TO-220 (N.ISOL)
MAC212-10FP	Q8012LH5	D	TO-220 (ISOL)
MAC212-4	Q2012RH5	D	TO-220 (N.ISOL)
MAC212-4FP	Q2012LH5	D	TO-220 (ISOL)
MAC212-6	Q4012RH5	D	TO-220 (N.ISOL)
MAC212-6FP	Q4012LH5	D	TO-220 (ISOL)
MAC212-8	Q6012RH5	D	TO-220 (N.ISOL)
MAC212-8FP	Q6012LH5	D	TO-220 (ISOL)
MAC212A10	Q8012RH5	S	TO-220 (N.ISOL)
MAC212A10FP	Q8012LH5	S	TO-220 (ISOL)
MAC212A4	Q2015RH5	S	TO-220 (N.ISOL)
MAC212A4FP	Q2012LH5	S	TO-220 (ISOL)
MAC212A6	Q4012RH5	S	TO-220 (N.ISOL)
MAC212A6FP	Q4012LH5	S	TO-220 (ISOL)
MAC212A8	Q6012RH5	S	TO-220 (N.ISOL)
MAC212A8FP	Q6012LH5	S	TO-220 (ISOL)
MAC213-10	Q8012RH5	D	TO-220 (N.ISOL)
MAC213-4	Q2012RH5	D	TO-220 (N.ISOL)
MAC213-6	Q4012RH5	D	TO-220 (N.ISOL)
MAC213-8	Q6012RH5	D	TO-220 (N.ISOL)
MAC218-10	Q8008R5	D	TO-220 (N.ISOL)
MAC218-10FP	Q8008L5	D	TO-220 (ISOL)
MAC218-2	Q2008R5	D	TO-220 (N.ISOL)
MAC218-3	Q2008R5	D	TO-220 (N.ISOL)
MAC218-4	Q2008R5	D	TO-220 (N.ISOL)
MAC218-4FP	Q2008L5	D	TO-220 (ISOL)
MAC218-5	Q4008R4	D	TO-220 (N.ISOL)
MAC218-6	Q4008R4	D	TO-220 (N.ISOL)
MAC218-6FP	Q4008L5	D	TO-220 (ISOL)
MAC218-7	Q4008R4	D	TO-220 (N.ISOL)
MAC218-8	Q6008R5	D	TO-220 (N.ISOL)
MAC218-8FP	Q6008L5	S	TO-220 (ISOL)
MAC218-A10	Q8008R5	S	TO-220 (N.ISOL)
MAC218-A10FP	Q8008L5	S	TO-220 (ISOL)
MAC218-A2	Q2008R4	S	TO-220 (N.ISOL)
MAC218-A3	Q2008R4	S	TO-220 (N.ISOL)
MAC218-A4	Q2008R4	S	TO-220 (N.ISOL)
MAC218-A4FP	Q2008L4	S	TO-220 (ISOL)
MAC218-A5	Q4008R4	S	TO-220 (N.ISOL)
MAC218-A6	Q4008R4	S	TO-220 (N.ISOL)
MAC218-A6FP	Q4008L4	S	TO-220 (ISOL)
MAC218-A7	Q5008R4	S	TO-220 (N.ISOL)
MAC218-A8	Q6008R5	S	TO-220 (N.ISOL)
MAC218-A8FP	Q6008L5	S	TO-220 (ISOL)
MAC219-10	Q8008R5	D	TO-220 (N.ISOL)
MAC219-4	Q2008R4	D	TO-220 (N.ISOL)
MAC219-6	Q4008R4	D	TO-220 (N.ISOL)
MAC219-8	Q6008R5	D	TO-220 (N.ISOL)
MAC220-2	Q2008R4	D	TO-220 (N.ISOL)
MAC220-3	Q2008R4	D	TO-220 (N.ISOL)
MAC220-5	Q4008R4	D	TO-220 (N.ISOL)
MAC220-7	Q5008R4	D	TO-220 (N.ISOL)
MAC220-9	Q7008R5	D	TO-220 (N.ISOL)
MAC221-2	Q2008R4	D	TO-220 (N.ISOL)
MAC221-3	Q2008R4	D	TO-220 (N.ISOL)
MAC221-5	Q4008R4	D	TO-220 (N.ISOL)
MAC221-7	Q5008R4	D	TO-220 (N.ISOL)
MAC221-9	Q7008R5	D	TO-220 (N.ISOL)
MAC222-1	Q2008R4	D	TO-220 (N.ISOL)
MAC222-10	Q8008R5	D	TO-220 (N.ISOL)
MAC222-2	Q2008R4	D	TO-220 (N.ISOL)
MAC222-3	Q2008R4	D	TO-220 (N.ISOL)
MAC222-4	Q2008R4	D	TO-220 (N.ISOL)
MAC222-5	Q4008R4	D	TO-220 (N.ISOL)
MAC222-6	Q4008R4	D	TO-220 (N.ISOL)
MAC222-7	Q5008R4	D	TO-220 (N.ISOL)

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Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MAC222-8	Q6008R5	D	TO-220 (N.ISOL)
MAC222-9	Q7008R5	D	TO-220 (N.ISOL)
MAC222A1	Q2008R4	S	TO-220 (N.ISOL)
MAC222A10	Q8008R5	S	TO-220 (N.ISOL)
MAC222A2	Q2008R4	S	TO-220 (N.ISOL)
MAC222A3	Q2008R4	S	TO-220 (N.ISOL)
MAC222A4	Q2008R4	S	TO-220 (N.ISOL)
MAC222A5	Q4008R4	S	TO-220 (N.ISOL)
MAC222A6	Q4008R4	S	TO-220 (N.ISOL)
MAC222A7	Q5008R4	S	TO-220 (N.ISOL)
MAC222A8	Q6008R5	S	TO-220 (N.ISOL)
MAC222A9	Q7008R5	S	TO-220 (N.ISOL)
MAC223-10	Q8025R5	S	TO-220 (N.ISOL)
MAC223-10FP	Q8025L6	S	TO-220 (ISOL)
MAC223-3	Q2025R5	S	TO-220 (N.ISOL)
MAC223-4	Q2025R5	S	TO-220 (N.ISOL)
MAC223-4FP	Q2025L6	S	TO-220 (ISOL)
MAC223-5	Q4025R5	S	TO-220 (N.ISOL)
MAC223-6	Q4025R5	S	TO-220 (N.ISOL)
MAC223-6FP	Q4025L6	S	TO-220 (ISOL)
MAC223-7	Q5025R5	S	TO-220 (N.ISOL)
MAC223-8	Q6025R5	S	TO-220 (N.ISOL)
MAC223-8FP	Q6025L6	S	TO-220 (ISOL)
MAC223-9	Q7025R5	S	TO-220 (N.ISOL)
MAC223A10	Q8025R5	S	TO-220 (N.ISOL)
MAC223A10FP	Q8025L6	S	TO-220 (ISOL)
MAC223A3	Q4025R5	S	TO-220 (N.ISOL)
MAC223A4	Q2025R5	S	TO-220 (N.ISOL)
MAC223A4FP	Q2025L6	S	TO-220 (ISOL)
MAC223A5	Q4025R5	S	TO-220 (N.ISOL)
MAC223A5FP	Q4025L6	S	TO-220 (ISOL)
MAC223A6	Q4025R5	S	TO-220 (N.ISOL)
MAC223A6FP	Q4025L6	S	TO-220 (ISOL)
MAC223A7	Q5025R5	S	TO-220 (N.ISOL)
MAC223A7FP	Q5025L6	S	TO-220 (ISOL)
MAC223A8	Q6025R5	S	TO-220 (N.ISOL)
MAC223A8FP	Q6025L6	S	TO-220 (ISOL)
MAC223A9	Q7025R5	S	TO-220 (N.ISOL)
MAC223A9FP	Q7025L6	S	TO-220 (ISOL)
MAC224-10	Q8040K7	S	TO-218 (ISOL)
MAC224-4	Q2040K7	S	TO-218 (ISOL)
MAC224-5	Q4040K7	S	TO-218 (ISOL)
MAC224-6	Q4040K7	S	TO-218 (ISOL)
MAC224-7	Q5040K7	S	TO-218 (ISOL)
MAC224-8	Q6040K7	S	TO-218 (ISOL)
MAC224A10	Q8040K7	S	TO-218 (ISOL)
MAC224A4	Q2040K7	S	TO-218 (ISOL)
MAC224A5	Q4040K7	S	TO-218 (ISOL)
MAC224A6	Q4040K7	S	TO-218 (ISOL)
MAC224A7	Q5040K7	S	TO-218 (ISOL)
MAC224A8	Q6040K7	S	TO-218 (ISOL)
MAC224A9	Q7040K7	S	TO-218 (ISOL)
MAC228-2	L2008L6	S	TO-220 (ISOL)
MAC228-3	L2008L6	S	TO-220 (ISOL)
MAC228-4	L2008L6	S	TO-220 (ISOL)
MAC228-4FP	L2008L6	D	TO-220 (ISOL)
MAC228-5	L4008L6	S	TO-220 (ISOL)
MAC228-6	L4008L6	S	TO-220 (ISOL)
MAC228-6FP	L4008L6	D	TO-220 (ISOL)
MAC228-7	L6008L6	S	TO-220 (ISOL)
MAC228-8	L6008L6	S	TO-220 (ISOL)
MAC228-8FP	L6008L6	D	TO-220 (ISOL)
MAC228A2	L2008L6	S	TO-220 (ISOL)
MAC228A3	L2008L6	S	TO-220 (ISOL)
MAC228A4	L2008L6	S	TO-220 (ISOL)
MAC228A4FP	L2008L6	S	TO-220 (ISOL)
MAC228A5	L4008L6	S	TO-220 (ISOL)
MAC228A6	L4008L6	S	TO-220 (ISOL)
MAC228A6FP	L4008L6	S	TO-220 (ISOL)
MAC228A7	L6008L6	S	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MAC228A8	L6008L6	S	TO-220 (ISOL)
MAC228A8FP	L6008L6	S	TO-220 (ISOL)
MAC229-4	L2008L6	S	TO-220 (ISOL)
MAC229-4FP	L2008L6	D	TO-220 (ISOL)
MAC229-6	L4008L6	S	TO-220 (ISOL)
MAC229-6FP	L4008L6	D	TO-220 (ISOL)
MAC229-8	L6008L6	S	TO-220 (ISOL)
MAC229-8FP	L6008L6	D	TO-220 (ISOL)
MAC229A4	L2008L6	S	TO-220 (ISOL)
MAC229A4FP	L2008L6	S	TO-220 (ISOL)
MAC229A6	L4008L6	S	TO-220 (ISOL)
MAC229A6FP	L4008L6	S	TO-220 (ISOL)
MAC229A8	L6008L6	S	TO-220 (ISOL)
MAC229A8FP	L6008L6	S	TO-220 (ISOL)
MAC229A8FP	L6008L6	S	TO-220 (ISOL)
MAC25-10	Q8025P	S	FASTPAK (ISOL)
MAC25-4	Q2025P	S	FASTPAK (ISOL)
MAC25-5	Q4025P	S	FASTPAK (ISOL)
MAC25-6	Q4025P	S	FASTPAK (ISOL)
MAC25-7	Q5025P	S	FASTPAK (ISOL)
MAC25-8	Q6025P	S	FASTPAK (ISOL)
MAC25-9	Q7025P	S	FASTPAK (ISOL)
MAC25A10	Q8025P	S	FASTPAK (ISOL)
MAC25A4	Q2025P	S	FASTPAK (ISOL)
MAC25A5	Q4025P	S	FASTPAK (ISOL)
MAC25A6	Q4025P	S	FASTPAK (ISOL)
MAC25A7	Q5025P	S	FASTPAK (ISOL)
MAC25A8	Q6025P	S	FASTPAK (ISOL)
MAC25A9	Q7025P	S	FASTPAK (ISOL)
MAC3010-15	Q2015R5	S	TO-220 (N.ISOL)
MAC3010-25	Q2025R5	S	TO-220 (N.ISOL)
MAC3010-4	L2004F31	S	TO-202 (N.ISOL)
MAC3010-8	Q2008R4	D	TO-220 (N.ISOL)
MAC3020-15	Q4015R5	S	TO-220 (N.ISOL)
MAC3020-25	Q4025R5	S	TO-220 (N.ISOL)
MAC3020-4	L4004F31	S	TO-202 (N.ISOL)
MAC3020-8	Q4008R4	D	TO-220 (N.ISOL)
MAC3030-15	Q2015R5	S	TO-220 (N.ISOL)
MAC3030-25	Q2025R5	S	TO-220 (N.ISOL)
MAC3030-4	L4004F41	S	TO-202 (N.ISOL)
MAC3030-8	Q2008R4	D	TO-220 (N.ISOL)
MAC3040-15	Q4015R5	S	TO-220 (N.ISOL)
MAC3040-25	Q4025R5	S	TO-220 (N.ISOL)
MAC3040-4	L4004F41	S	TO-202 (N.ISOL)
MAC3040-8	Q4008R4	D	TO-220 (N.ISOL)
MAC320-10	Q8025R5	S	TO-220 (N.ISOL)
MAC320-10FP	Q8025L6	S	TO-220 (ISOL)
MAC320-4	Q2025R5	S	TO-220 (N.ISOL)
MAC320-4FP	Q2025L6	S	TO-220 (ISOL)
MAC320-6	Q4025R5	S	TO-220 (N.ISOL)
MAC320-6FP	Q4025L6	S	TO-220 (ISOL)
MAC320-8	Q6025R5	S	TO-220 (N.ISOL)
MAC320-8FP	Q6025L6	S	TO-220 (ISOL)
MAC320A10	Q8025R5	S	TO-220 (N.ISOL)
MAC320A4	Q2025R5	S	TO-220 (N.ISOL)
MAC320A6	Q4025R5	S	TO-220 (N.ISOL)
MAC320A8	Q6025R5	S	TO-220 (N.ISOL)
MAC321-10	Q8025R5	D	TO-220 (N.ISOL)
MAC321-4	Q2025R5	D	TO-220 (N.ISOL)
MAC321-6	Q4025R5	D	TO-220 (N.ISOL)
MAC321-8	Q6025R5	D	TO-220 (N.ISOL)
MAC50-4	Q2040P	S	FASTPAK (ISOL)
MAC50-5	Q4040P	S	FASTPAK (ISOL)
MAC50-6	Q4040P	S	FASTPAK (ISOL)
MAC50-7	Q5040P	S	FASTPAK (ISOL)
MAC50-8	Q6040P	S	FASTPAK (ISOL)
MAC50-9	Q7040P	S	FASTPAK (ISOL)
MAC50A4	Q2040P	S	FASTPAK (ISOL)
MAC50A5	Q4040P	S	FASTPAK (ISOL)
MAC50A6	Q4040P	S	FASTPAK (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MAC50A7	Q5040P	S	FASTPAK (ISOL)
MAC50A8	Q6040P	S	FASTPAK (ISOL)
MAC50A9	Q7040P	S	FASTPAK (ISOL)
MAC515-10	Q8025P	S	FASTPAK (ISOL)
MAC515-4	Q2025P	S	FASTPAK (ISOL)
MAC515-5	Q4025P	S	FASTPAK (ISOL)
MAC515-6	Q4025P	S	FASTPAK (ISOL)
MAC515-7	Q5025P	S	FASTPAK (ISOL)
MAC515-8	Q6025P	S	FASTPAK (ISOL)
MAC515-9	Q7025P	S	FASTPAK (ISOL)
MAC515A10	Q8025P	S	FASTPAK (ISOL)
MAC515A4	Q2025P	S	FASTPAK (ISOL)
MAC515A5	Q4025P	S	FASTPAK (ISOL)
MAC515A6	Q4025P	S	FASTPAK (ISOL)
MAC515A7	Q5025P	S	FASTPAK (ISOL)
MAC515A8	Q6025P	S	FASTPAK (ISOL)
MAC515A9	Q7025P	S	FASTPAK (ISOL)
MAC525-10	Q8025P	S	FASTPAK (ISOL)
MAC525-4	Q2025P	S	FASTPAK (ISOL)
MAC525-5	Q4025P	S	FASTPAK (ISOL)
MAC525-6	Q4025P	S	FASTPAK (ISOL)
MAC525-7	Q5025P	S	FASTPAK (ISOL)
MAC525-8	Q6025P	S	FASTPAK (ISOL)
MAC525-9	Q7025P	S	FASTPAK (ISOL)
MAC525A10	Q8025P	S	FASTPAK (ISOL)
MAC525A4	Q2025P	S	FASTPAK (ISOL)
MAC525A5	Q4025P	S	FASTPAK (ISOL)
MAC525A6	Q4025P	S	FASTPAK (ISOL)
MAC525A7	Q5025P	S	FASTPAK (ISOL)
MAC525A8	Q6025P	S	FASTPAK (ISOL)
MAC525A9	Q7025P	S	FASTPAK (ISOL)
MAC625-4	Q2025P	S	FASTPAK (ISOL)
MAC625-6	Q4025P	S	FASTPAK (ISOL)
MAC625-8	Q6025P	S	FASTPAK (ISOL)
MAC635-4	Q2040P	S	FASTPAK (ISOL)
MAC635-6	Q4040P	S	FASTPAK (ISOL)
MAC635-8	Q6040P	S	FASTPAK (ISOL)
MAC91-1	Q2X8E3	D	TO-92 (ISOL)
MAC91-2	Q2X8E3	D	TO-92 (ISOL)
MAC91-3	Q2X8E3	D	TO-92 (ISOL)
MAC91-4	Q2X8E3	D	TO-92 (ISOL)
MAC91-5	Q4X8E3	D	TO-92 (ISOL)
MAC91-6	Q4X8E3	D	TO-92 (ISOL)
MAC91-7	Q5X8E3	D	TO-92 (ISOL)
MAC91-8	Q6X8E3	D	TO-92 (ISOL)
MAC91A1	L2X8E6	D	TO-92 (ISOL)
MAC91A2	L2X8E6	D	TO-92 (ISOL)
MAC91A3	L2X8E6	D	TO-92 (ISOL)
MAC91A4	L2X8E6	D	TO-92 (ISOL)
MAC91A5	L4X8E6	D	TO-92 (ISOL)
MAC91A6	L4X8E6	D	TO-92 (ISOL)
MAC91A7	L6X8E6	D	TO-92 (ISOL)
MAC91A8	L6X8E6	D	TO-92 (ISOL)
MAC92-1	L2X8E5	D	TO-92 (ISOL)
MAC92-2	L2X8E5	D	TO-92 (ISOL)
MAC92-3	L2X8E5	D	TO-92 (ISOL)
MAC92-4	L2X8E5	D	TO-92 (ISOL)
MAC92-5	L4X8E5	D	TO-92 (ISOL)
MAC92-6	L4X8E5	D	TO-92 (ISOL)
MAC92-7	L6X8E5	D	TO-92 (ISOL)
MAC92-8	L6X8E5	D	TO-92 (ISOL)
MAC92A1	L2X8E5	D	TO-92 (ISOL)
MAC92A2	L2X8E5	D	TO-92 (ISOL)
MAC92A3	L2X8E5	D	TO-92 (ISOL)
MAC92A4	L2X8E5	D	TO-92 (ISOL)
MAC92A5	L4X8E5	D	TO-92 (ISOL)
MAC92A6	L4X8E5	D	TO-92 (ISOL)
MAC92A7	L6X8E5	D	TO-92 (ISOL)
MAC92A8	L6X8E5	D	TO-92 (ISOL)
MAC93-1	L2X8E3	D	TO-92 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MAC93-2	L2X8E3	D	TO-92 (ISOL)
MAC93-3	L2X8E3	D	TO-92 (ISOL)
MAC93-4	L2X8E3	D	TO-92 (ISOL)
MAC93-5	L4X8E3	D	TO-92 (ISOL)
MAC93-6	L4X8E3	D	TO-92 (ISOL)
MAC93-7	L6X8E3	D	TO-92 (ISOL)
MAC93-8	L6X8E3	D	TO-92 (ISOL)
MAC93A1	Q2X8E3	D	TO-92 (ISOL)
MAC93A2	Q2X8E3	D	TO-92 (ISOL)
MAC93A3	Q2X8E3	D	TO-92 (ISOL)
MAC93A4	Q2X8E3	D	TO-92 (ISOL)
MAC93A5	L4X8E3	D	TO-92 (ISOL)
MAC93A6	L4X8E3	D	TO-92 (ISOL)
MAC93A7	L6X8E3	D	TO-92 (ISOL)
MAC93A8	L6X8E3	D	TO-92 (ISOL)
MAC94-1	Q2X8E3	D	TO-92 (ISOL)
MAC94-2	Q2X8E3	D	TO-92 (ISOL)
MAC94-3	Q2X8E3	D	TO-92 (ISOL)
MAC94-4	Q2X8E3	D	TO-92 (ISOL)
MAC94-5	Q4X8E3	D	TO-92 (ISOL)
MAC94-6	Q4X8E3	D	TO-92 (ISOL)
MAC94-7	Q5X8E3	D	TO-92 (ISOL)
MAC94-8	Q6X8E3	D	TO-92 (ISOL)
MAC94A1	L2X8E6	D	TO-92 (ISOL)
MAC94A2	L2X8E6	D	TO-92 (ISOL)
MAC94A3	L2X8E6	D	TO-92 (ISOL)
MAC94A4	L2X8E6	D	TO-92 (ISOL)
MAC94A5	L4X8E6	D	TO-92 (ISOL)
MAC94A6	L4X8E6	D	TO-92 (ISOL)
MAC94A7	L6X8E6	D	TO-92 (ISOL)
MAC94A8	L6X8E6	D	TO-92 (ISOL)
MAC95-1	L2X8E5	D	TO-92 (ISOL)
MAC95-2	L2X8E5	D	TO-92 (ISOL)
MAC95-3	L2X8E5	D	TO-92 (ISOL)
MAC95-4	L2X8E5	D	TO-92 (ISOL)
MAC95-5	L4X8E5	D	TO-92 (ISOL)
MAC95-6	L4X8E5	D	TO-92 (ISOL)
MAC95-7	L6X8E5	D	TO-92 (ISOL)
MAC95-8	L6X8E5	D	TO-92 (ISOL)
MAC95A1	L2X8E5	D	TO-92 (ISOL)
MAC95A2	L2X8E5	D	TO-92 (ISOL)
MAC95A3	L2X8E5	D	TO-92 (ISOL)
MAC95A4	L2X8E5	D	TO-92 (ISOL)
MAC95A5	L4X8E5	D	TO-92 (ISOL)
MAC95A6	L4X8E5	D	TO-92 (ISOL)
MAC95A7	L6X8E5	D	TO-92 (ISOL)
MAC95A8	L6X8E5	D	TO-92 (ISOL)
MAC96-1	L2X8E3	D	TO-92 (ISOL)
MAC96-2	L2X8E3	D	TO-92 (ISOL)
MAC96-3	L2X8E3	D	TO-92 (ISOL)
MAC96-4	L2X8E3	D	TO-92 (ISOL)
MAC96-5	L4X8E3	D	TO-92 (ISOL)
MAC96-6	L4X8E3	D	TO-92 (ISOL)
MAC96-7	L6X8E3	D	TO-92 (ISOL)
MAC96-8	L6X8E3	D	TO-92 (ISOL)
MAC96A1	L2X8E3	D	TO-92 (ISOL)
MAC96A2	L2X8E3	D	TO-92 (ISOL)
MAC96A3	L2X8E3	D	TO-92 (ISOL)
MAC96A4	L2X8E3	D	TO-92 (ISOL)
MAC96A5	L4X8E3	D	TO-92 (ISOL)
MAC96A6	L4X8E3	D	TO-92 (ISOL)
MAC96A7	L6X8E3	D	TO-92 (ISOL)
MAC96A8	L6X8E3	D	TO-92 (ISOL)
MAC97-2	L2X8E6	D	TO-92 (ISOL)
MAC97-3	L2X8E6	D	TO-92 (ISOL)
MAC97-4	L2X8E6	D	TO-92 (ISOL)
MAC97-5	L4X8E6	D	TO-92 (ISOL)
MAC97-6	L4X8E6	D	TO-92 (ISOL)
MAC97-7	L6X8E6	D	TO-92 (ISOL)
MAC97-8	L6X8E6	D	TO-92 (ISOL)

Cross Reference Guide

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MAC97A2	L2X8E5	D	TO-92 (ISOL)
MAC97A3	L2X8E5	D	TO-92 (ISOL)
MAC97A4	L2X8E5	D	TO-92 (ISOL)
MAC97A5	L4X8E5	D	TO-92 (ISOL)
MAC97A6	L4X8E5	D	TO-92 (ISOL)
MAC97A7	L6X8E5	D	TO-92 (ISOL)
MAC97A8	L6X8E5	D	TO-92 (ISOL)
MAC97B2	L2X8E3	D	TO-92 (ISOL)
MAC97B3	L2X8E3	D	TO-92 (ISOL)
MAC97B4	L2X8E3	D	TO-92 (ISOL)
MAC97B5	L4X8E3	D	TO-92 (ISOL)
MAC97B6	L4X8E3	D	TO-92 (ISOL)
MAC97B7	L6X8E3	D	TO-92 (ISOL)
MAC97B8	L6X8E3	D	TO-92 (ISOL)
MCR100-3	EC103A	D	TO-92 (ISOL)
MCR100-4	EC103B	D	TO-92 (ISOL)
MCR100-5	EC103C	D	TO-92 (ISOL)
MCR100-6	EC103D	D	TO-92 (ISOL)
MCR100-7	EC103E	D	TO-92 (ISOL)
MCR100-8	EC103M	D	TO-92 (ISOL)
MCR101	EC103A	D	TO-92 (ISOL)
MCR102	EC103A	D	TO-92 (ISOL)
MCR103	EC103A	D	TO-92 (ISOL)
MCR106-1	T106F1	D	TO-202 (N.ISOL)
MCR106-2	T106F1	D	TO-202 (N.ISOL)
MCR106-3	T106A1	D	TO-202 (N.ISOL)
MCR106-4	T106B1	D	TO-202 (N.ISOL)
MCR106-5	T106C1	D	TO-202 (N.ISOL)
MCR106-6	T106D1	D	TO-202 (N.ISOL)
MCR106-7	T106E1	D	TO-202 (N.ISOL)
MCR106-8	T106M1	D	TO-202 (N.ISOL)
MCR120	EC103B	D	TO-92 (ISOL)
MCR202	EC103A	S	TO-92 (ISOL)
MCR203	EC103A	S	TO-92 (ISOL)
MCR204	EC103A	S	TO-92 (ISOL)
MCR206	EC103B	S	TO-92 (ISOL)
MCR218-10FP	S8008L	D	TO-220 (ISOL)
MCR218-2	S0508R	D	TO-220 (N.ISOL)
MCR218-2FP	S0508L	D	TO-220 (ISOL)
MCR218-3	S1008R	D	TO-220 (N.ISOL)
MCR218-3FP	S1008L	D	TO-220 (ISOL)
MCR218-4	S2008R	D	TO-220 (N.ISOL)
MCR218-4FP	S2008L	D	TO-220 (ISOL)
MCR218-5	S4008R	D	TO-220 (N.ISOL)
MCR218-6	S4008R	D	TO-220 (N.ISOL)
MCR218-6FP	S4008L	D	TO-220 (ISOL)
MCR218-7	S6008R	D	TO-220 (N.ISOL)
MCR218-8	S6008R	D	TO-220 (N.ISOL)
MCR218-8FP	S6008L	D	TO-220 (ISOL)
MCR22-1	TCR22-2	S	TO-92 (ISOL)
MCR22-2	TCR22-2	D	TO-92 (ISOL)
MCR22-3	TCR22-3	D	TO-92 (ISOL)
MCR22-4	TCR22-4	D	TO-92 (ISOL)
MCR22-6	TCR22-6	D	TO-92 (ISOL)
MCR22-7	TCR22-8	D	TO-92 (ISOL)
MCR22-8	TCR22-8	D	TO-92 (ISOL)
MCR220-5	S4012R	D	TO-220 (N.ISOL)
MCR220-7	S6012R	D	TO-220 (N.ISOL)
MCR220-9	S8012R	D	TO-220 (N.ISOL)
MCR221-5	S4016R	D	TO-220 (N.ISOL)
MCR221-7	S6016R	D	TO-220 (N.ISOL)
MCR221-9	S8016R	D	TO-220 (N.ISOL)
MCR225-10FP	S8025L	S	TO-220 (ISOL)
MCR225-2FP	S0525L	S	TO-220 (ISOL)
MCR225-4FP	S2025L	S	TO-220 (ISOL)
MCR225-5	S4025R	S	TO-220 (N.ISOL)
MCR225-6FP	S4025L	S	TO-220 (ISOL)
MCR225-7	S6025R	S	TO-220 (N.ISOL)
MCR225-8FP	S6025L	S	TO-220 (ISOL)
MCR225-9	S8025R	S	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MCR264-10	S8040R	D	TO-220 (N.ISOL)
MCR264-2	S0540R	D	TO-220 (N.ISOL)
MCR264-3	S1040R	D	TO-220 (N.ISOL)
MCR264-4	S2040R	D	TO-220 (N.ISOL)
MCR264-6	S4040R	D	TO-220 (N.ISOL)
MCR265-10	S8055R	D	TO-220 (N.ISOL)
MCR265-2	S0555R	D	TO-220 (N.ISOL)
MCR265-3	S1055R	D	TO-220 (N.ISOL)
MCR265-4	S2055R	D	TO-220 (N.ISOL)
MCR265-6	S4055R	D	TO-220 (N.ISOL)
MCR265-8	S6055R	D	TO-220 (N.ISOL)
MCR3000-1	S0508R	S	TO-220 (N.ISOL)
MCR3000-10	S8008R	S	TO-220 (N.ISOL)
MCR3000-2	S0508R	S	TO-220 (N.ISOL)
MCR3000-3	S1008R	S	TO-220 (N.ISOL)
MCR3000-4	S2008R	S	TO-220 (N.ISOL)
MCR3000-5	S4008R	S	TO-220 (N.ISOL)
MCR3000-6	S4008R	S	TO-220 (N.ISOL)
MCR3000-7	S5008R	S	TO-220 (N.ISOL)
MCR3000-8	S6008R	S	TO-220 (N.ISOL)
MCR3000-9	S8008R	S	TO-220 (N.ISOL)
MCR310-1	S0510LS2	S	TO-220 (ISOL)
MCR310-2	S0510LS2	S	TO-220 (ISOL)
MCR310-3	S1010LS2	S	TO-220 (ISOL)
MCR310-4	S2010LS2	S	TO-220 (ISOL)
MCR310-5	S4010LS2	S	TO-220 (ISOL)
MCR310-6	S4010LS2	S	TO-220 (ISOL)
MCR310-7	S6010LS2	S	TO-220 (ISOL)
MCR310-8	S6010LS2	S	TO-220 (ISOL)
MCR506-1	S2006FS21	S	TO-202 (N.ISOL)
MCR506-2	S2006FS21	S	TO-202 (N.ISOL)
MCR506-3	S2006FS21	S	TO-202 (N.ISOL)
MCR506-4	S2006FS21	S	TO-202 (N.ISOL)
MCR506-6	S4006FS21	S	TO-202 (N.ISOL)
MCR506-8	S6006FS21	S	TO-202 (N.ISOL)
MCR525-1	S2035J	S	TO-218 (ISOL)
MCR525-2	S2035J	S	TO-218 (ISOL)
MCR525-3	S2035J	S	TO-218 (ISOL)
MCR525-6	S4035J	S	TO-218 (ISOL)
MCR68-1	S0512R	D	TO-220 (N.ISOL)
MCR68-2	S0512R	D	TO-220 (N.ISOL)
MCR68-3	S1012R	D	TO-220 (N.ISOL)
MCR68-6	S4012R	D	TO-220 (N.ISOL)
MCR69-1	S0525R	D	TO-220 (N.ISOL)
MCR69-2	S0525R	D	TO-220 (N.ISOL)
MCR69-3	S1025R	D	TO-220 (N.ISOL)
MCR69-6	S4025R	D	TO-220 (N.ISOL)
MCR72-1	S0508LS2	S	TO-220 (ISOL)
MCR72-2	S0508LS2	S	TO-220 (ISOL)
MCR72-3	S1008LS2	S	TO-220 (ISOL)
MCR72-4	S2008LS2	S	TO-220 (ISOL)
MCR72-5	S4008LS2	S	TO-220 (ISOL)
MCR72-6	S4008LS2	S	TO-220 (ISOL)
MCR72-7	S6008LS2	S	TO-220 (ISOL)
MCR72-8	S6008LS2	S	TO-220 (ISOL)
MK1V115	K1100G	S	DO-15X
MK1V125	K1200G	S	DO-15X
MK1V135	K1300G	S	DO-15X
MK1V240	K2400G	S	DO-15X
MK1V260	K2500G	S	DO-15X
MK1V270	K2500G	S	DO-15X
MK1V280	K2500G	S	DO-15X
MKP1V120	K1200E70	S	TO-92 (ISOL)
MKP1V130	K1300E70	S	TO-92 (ISOL)
MKP1V240	K2400E70	S	TO-92 (ISOL)
MKP3V110	K1100G	S	DO-15X
MKP3V120	K1200G	S	DO-15X
MKP3V130	K1300G	S	DO-15X
MKP9V120	K1200E70	S	TO-92 (ISOL)
MKP9V130	K1300E70	S	TO-92 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
MKP9V240	K2400E70	S	TO-92 (ISOL)
MKP9V260	K2500E70	S	TO-92 (ISOL)
MKP9V270	K2500E70	S	TO-92 (ISOL)
MN611A	K1050E70	S	TO-92 (ISOL)
PO100AA	EC103A1	D	TO-92 (ISOL)
PO100AB	EC103A1	S	TO-92 (ISOL)
PO100BA	EC103B1	D	TO-92 (ISOL)
PO100BB	EC103B1	S	TO-92 (ISOL)
PO100CA	EC103C1	D	TO-92 (ISOL)
PO100CB	EC103C1	S	TO-92 (ISOL)
PO100DA	EC103D1	D	TO-92 (ISOL)
PO100DB	EC103D1	S	TO-92 (ISOL)
PO101AA	EC103A1	D	TO-92 (ISOL)
PO101AB	EC103A1	S	TO-92 (ISOL)
PO101BA	EC103B1	D	TO-92 (ISOL)
PO101BB	EC103B1	S	TO-92 (ISOL)
PO101CA	EC103C1	D	TO-92 (ISOL)
PO101CB	EC103C1	S	TO-92 (ISOL)
PO101DA	EC103D1	D	TO-92 (ISOL)
PO101DB	EC103D1	S	TO-92 (ISOL)
PO102AA	EC103A	D	TO-92 (ISOL)
PO102AB	EC103A	S	TO-92 (ISOL)
PO102AD	EC103A78	S	TO-92 (ISOL)
PO102BA	EC103B	D	TO-92 (ISOL)
PO102BB	EC103B	S	TO-92 (ISOL)
PO102BD	EC103B78	S	TO-92 (ISOL)
PO102CA	EC103C	D	TO-92 (ISOL)
PO102CB	EC103C	S	TO-92 (ISOL)
PO102CD	EC103C78	S	TO-92 (ISOL)
PO102DA	EC103D	D	TO-92 (ISOL)
PO102DB	EC103D	S	TO-92 (ISOL)
PO102DD	EC103D78	S	TO-92 (ISOL)
PO103AA	EC103A	D	TO-92 (ISOL)
PO103AB	EC103A	S	TO-92 (ISOL)
PO103BA	EC103B	D	TO-92 (ISOL)
PO103BB	EC103B	S	TO-92 (ISOL)
PO103CA	EC103C	D	TO-92 (ISOL)
PO103CB	EC103C	S	TO-92 (ISOL)
PO103DA	EC103D	D	TO-92 (ISOL)
PO103DB	EC103D	S	TO-92 (ISOL)
PO104AA	EC103A2	D	TO-92 (ISOL)
PO104AB	EC103A2	S	TO-92 (ISOL)
PO104BA	EC103B2	D	TO-92 (ISOL)
PO104BB	EC103B2	S	TO-92 (ISOL)
PO104CA	EC103C2	D	TO-92 (ISOL)
PO104CB	EC103C2	S	TO-92 (ISOL)
PO104DA	EC103D2	D	TO-92 (ISOL)
PO104DB	EC103D2	S	TO-92 (ISOL)
PO105AA	EC103A2	S	TO-92 (ISOL)
PO105AB	EC103A2	S	TO-92 (ISOL)
PO105BA	EC103B2	S	TO-92 (ISOL)
PO105BB	EC103B2	S	TO-92 (ISOL)
PO105CA	EC103C2	S	TO-92 (ISOL)
PO105CB	EC103C2	S	TO-92 (ISOL)
PO105DA	EC103D2	S	TO-92 (ISOL)
PO105DB	EC103D2	S	TO-92 (ISOL)
PO110AA	EC103A1	S	TO-92 (ISOL)
PO110AB	EC103A1	S	TO-92 (ISOL)
PO110BA	EC103B1	S	TO-92 (ISOL)
PO110BB	EC103B1	S	TO-92 (ISOL)
PO110CA	EC103C1	S	TO-92 (ISOL)
PO110CB	EC103C1	S	TO-92 (ISOL)
PO110DA	EC103D1	S	TO-92 (ISOL)
PO110DB	EC103D1	S	TO-92 (ISOL)
PT20	D2015L	D	TO-220 (ISOL)
PT40	D4015L	D	TO-220 (ISOL)
PT60	D6015L	D	TO-220 (ISOL)
S0402BH	T106B1	S	TO-202 (N.ISOL)
S0402DH	T106D1	S	TO-202 (N.ISOL)
S0402MH	T106M1	S	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
S0405BH	S2006L	S	TO-220 (ISOL)
S0405DH	S4006L	S	TO-220 (ISOL)
S0405MH	S6006L	S	TO-220 (ISOL)
S0407BH	S2006L	S	TO-220 (ISOL)
S0407DH	S4006L	S	TO-220 (ISOL)
S0407MH	S6006L	S	TO-220 (ISOL)
S0410BH	S2006L	S	TO-220 (ISOL)
S0410DH	S4006L	S	TO-220 (ISOL)
S0410MH	S6006L	S	TO-220 (ISOL)
S0602BH	S2006LS2	S	TO-220 (ISOL)
S0602DH	S4006LS2	S	TO-220 (ISOL)
S0602MH	S6006LS2	S	TO-220 (ISOL)
S0605BH	S2006L	S	TO-220 (ISOL)
S0605DH	S4006L	S	TO-220 (ISOL)
S0605MH	S6006L	S	TO-220 (ISOL)
S0607BH	S2006L	S	TO-220 (ISOL)
S0607DH	S4006L	S	TO-220 (ISOL)
S0607MH	S6006L	S	TO-220 (ISOL)
S0610BH	S2006L	S	TO-220 (ISOL)
S0610DH	S4006L	S	TO-220 (ISOL)
S0610MH	S6006L	S	TO-220 (ISOL)
S0802BH	S2008LS2	S	TO-220 (ISOL)
S0802DH	S4008LS2	S	TO-220 (ISOL)
S0802MH	S6008LS2	S	TO-220 (ISOL)
S0805BH	S2008R	S	TO-220 (N.ISOL)
S0805DH	S4008R	S	TO-220 (N.ISOL)
S0805MH	S6008R	S	TO-220 (N.ISOL)
S0807BH	S2008R	S	TO-220 (N.ISOL)
S0807DH	S4008R	S	TO-220 (N.ISOL)
S0807MH	S6008R	S	TO-220 (N.ISOL)
S0807NH	S8008R	S	TO-220 (N.ISOL)
S0810BH	S2008R	S	TO-220 (N.ISOL)
S0810DH	S4008R	S	TO-220 (N.ISOL)
S0810MH	S6008R	S	TO-220 (N.ISOL)
S1005BH	S2010R	S	TO-220 (N.ISOL)
S1005DH	S4010R	S	TO-220 (N.ISOL)
S1005MH	S6010R	S	TO-220 (N.ISOL)
S1007BH	S2010R	S	TO-220 (N.ISOL)
S1007DH	S4010R	S	TO-220 (N.ISOL)
S1007MH	S6010R	S	TO-220 (N.ISOL)
S1010BH	S2010R	S	TO-220 (N.ISOL)
S1010DH	S4010R	S	TO-220 (N.ISOL)
S1010MH	S6010R	S	TO-220 (N.ISOL)
S106A1	T106A1	D	TO-202 (N.ISOL)
S106B1	T106B1	D	TO-202 (N.ISOL)
S106C1	T106C1	D	TO-202 (N.ISOL)
S106D1	T106D1	D	TO-202 (N.ISOL)
S106E1	T106E1	D	TO-202 (N.ISOL)
S106F1	T106F1	D	TO-202 (N.ISOL)
S106M1	T106M1	D	TO-202 (N.ISOL)
S106Y1	T106F1	D	TO-202 (N.ISOL)
S107A1	T107A1	D	TO-202 (N.ISOL)
S107B1	T107B1	D	TO-202 (N.ISOL)
S107C1	T107C1	D	TO-202 (N.ISOL)
S107D1	T107D1	D	TO-202 (N.ISOL)
S107E1	T107E1	D	TO-202 (N.ISOL)
S107F1	T107F1	D	TO-202 (N.ISOL)
S107M1	T107M1	D	TO-202 (N.ISOL)
S107Q1	T107F1	S	TO-202 (N.ISOL)
S107Y1	T107F1	S	TO-202 (N.ISOL)
S1205BH	S2012R	S	TO-220 (N.ISOL)
S1205DH	S4012R	S	TO-220 (N.ISOL)
S1205MH	S6012R	S	TO-220 (N.ISOL)
S1207BH	S2012R	S	TO-220 (N.ISOL)
S1207DH	S4012R	S	TO-220 (N.ISOL)
S1207MH	S6012R	S	TO-220 (N.ISOL)
S1210BH	S2012R	S	TO-220 (N.ISOL)
S1210DH	S4012R	S	TO-220 (N.ISOL)
S1210MH	S6012R	S	TO-220 (N.ISOL)
S1210NH	S8012R	S	TO-220 (N.ISOL)

Cross Reference Guide

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
S1610BH	S2016R	S	TO-220 (N.ISOL)
S1610DH	S4016R	S	TO-220 (N.ISOL)
S1610MH	S6016R	S	TO-220 (N.ISOL)
S1610NH	S8016R	S	TO-220 (N.ISOL)
S1612BH	S2016R	S	TO-220 (N.ISOL)
S1612DH	S4016R	S	TO-220 (N.ISOL)
S1612MH	S6016R	S	TO-220 (N.ISOL)
S1612NH	S8016R	S	TO-220 (N.ISOL)
S1616BH	S2016R	S	TO-220 (N.ISOL)
S1616DH	S4016R	S	TO-220 (N.ISOL)
S1616MH	S6016R	S	TO-220 (N.ISOL)
S1616NH	S8016R	S	TO-220 (N.ISOL)
S1A	EC103A	D	TO-92 (ISOL)
S1B	EC103B	D	TO-92 (ISOL)
S1D	EC103D	D	TO-92 (ISOL)
S1M	EC103M	D	TO-92 (ISOL)
S1Y	EC103A	D	TO-92 (ISOL)
S1YY	EC103A	D	TO-92 (ISOL)
S2060A	S1006LS2	S	TO-220 (ISOL)
S2060B	S2006LS2	S	TO-220 (ISOL)
S2060C	S4006LS2	S	TO-220 (ISOL)
S2060D	S4006LS2	S	TO-220 (ISOL)
S2060E	S6006LS2	S	TO-220 (ISOL)
S2060F	S0506LS2	S	TO-220 (ISOL)
S2060M	S6006LS2	S	TO-220 (ISOL)
S2060Y	S0506LS2	S	TO-220 (ISOL)
S2061A	S1006LS3	S	TO-220 (ISOL)
S2061B	S2006LS3	S	TO-220 (ISOL)
S2061C	S4006LS3	S	TO-220 (ISOL)
S2061D	S4006LS3	S	TO-220 (ISOL)
S2061E	S6006LS3	S	TO-220 (ISOL)
S2061F	S0506LS3	S	TO-220 (ISOL)
S2061Q	S0506LS3	S	TO-220 (ISOL)
S2061Y	S0506LS3	S	TO-220 (ISOL)
S2062A	S1006LS3	S	TO-220 (ISOL)
S2062B	S2006LS3	S	TO-220 (ISOL)
S2062C	S4006LS3	S	TO-220 (ISOL)
S2062D	S4006LS3	S	TO-220 (ISOL)
S2062E	S6006LS3	S	TO-220 (ISOL)
S2062F	S0506LS3	S	TO-220 (ISOL)
S2062M	S6006LS3	S	TO-220 (ISOL)
S2062Q	S0506LS3	S	TO-220 (ISOL)
S2062Y	S0506LS3	S	TO-220 (ISOL)
S2512BH	S2025R	S	TO-220 (N.ISOL)
S2512BK	S2035J	S	TO-218 (ISOL)
S2512DH	Q4025R	S	TO-220 (N.ISOL)
S2512DK	S4035J	S	TO-218 (ISOL)
S2512MH	S6025R	S	TO-220 (N.ISOL)
S2512MK	S6035J	S	TO-218 (ISOL)
S2512NH	S8025R	S	TO-220 (N.ISOL)
S2512NK	S8035J	S	TO-218 (ISOL)
S2514BH	S2025R	S	TO-220 (N.ISOL)
S2514BK	S2035J	S	TO-218 (ISOL)
S2514DH	S4025R	S	TO-220 (N.ISOL)
S2514DK	S4035J	S	TO-218 (ISOL)
S2514MH	S6025R	S	TO-220 (N.ISOL)
S2514MK	S6035J	S	TO-218 (ISOL)
S2514NH	S8025R	S	TO-220 (N.ISOL)
S2514NK	S8035J	S	TO-218 (ISOL)
S2600B	S2006L	S	TO-220 (ISOL)
S2600D	S4006L	S	TO-220 (ISOL)
S2600M	S6006L	S	TO-220 (ISOL)
S2800A	S1010R	D	TO-220 (N.ISOL)
S2800B	S2010R	D	TO-220 (N.ISOL)
S2800C	S4010R	S	TO-220 (N.ISOL)
S2800D	S4010R	D	TO-220 (N.ISOL)
S2800E	S6010R	S	TO-220 (N.ISOL)
S2800F	S0510R	D	TO-220 (N.ISOL)
S2800M	S6010R	D	TO-220 (N.ISOL)
S2800N	S8010R	D	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
S4012BH	S2040R	S	TO-220 (N.ISOL)
S4012BK	S2035J	S	TO-218 (ISOL)
S4012DH	S4040R	S	TO-220 (N.ISOL)
S4012DK	S4035J	S	TO-218 (ISOL)
S4012MH	S6040R	S	TO-220 (N.ISOL)
S4012MK	S6035J	S	TO-218 (ISOL)
S4012NH	S8040R	S	TO-220 (N.ISOL)
S4012NK	S8035J	S	TO-218 (ISOL)
S4014BH	S2040R	S	TO-220 (N.ISOL)
S4014BK	S2035J	S	TO-218 (ISOL)
S4014DH	S4040R	S	TO-220 (N.ISOL)
S4014DK	S4035J	S	TO-218 (ISOL)
S4014MH	S6040R	S	TO-220 (N.ISOL)
S4014MK	S6035J	S	TO-218 (ISOL)
S4014NH	S8040R	S	TO-220 (N.ISOL)
S4014NK	S8065J	S	TO-218 (ISOL)
S4060A	S2010LS2	S	TO-220 (ISOL)
S4060B	S2010LS2	S	TO-220 (ISOL)
S4060C	S4010LS2	S	TO-220 (ISOL)
S4060D	S4010LS2	S	TO-220 (ISOL)
S4060F	S0510LS2	S	TO-220 (ISOL)
S4060U	S0510LS2	S	TO-220 (ISOL)
S5800B	S2008R	S	TO-220 (N.ISOL)
S5800C	S4008R	S	TO-220 (N.ISOL)
S5800D	S4008R	S	TO-220 (N.ISOL)
S5800E	S6008R	S	TO-220 (N.ISOL)
S5800M	S6008R	S	TO-220 (N.ISOL)
SC129B	Q2025R5	D	TO-220 (N.ISOL)
SC129D	Q4025R5	D	TO-220 (N.ISOL)
SC129E	Q5025R5	D	TO-220 (N.ISOL)
SC129M	Q6025R5	D	TO-220 (N.ISOL)
SC136A	Q2004F41	S	TO-202 (N.ISOL)
SC136B	Q2004F41	S	TO-202 (N.ISOL)
SC136C	Q4004F41	S	TO-202 (N.ISOL)
SC136D	Q4004F41	S	TO-202 (N.ISOL)
SC136E	Q5004F41	S	TO-202 (N.ISOL)
SC136M	Q6004F41	S	TO-202 (N.ISOL)
SC140B	Q2006L4	D	TO-220 (ISOL)
SC140D	Q4006L4	D	TO-220 (ISOL)
SC140E	Q5006L4	D	TO-220 (ISOL)
SC140M	Q6006L5	D	TO-220 (ISOL)
SC141A	Q2006R4	S	TO-220 (N.ISOL)
SC141B	Q2006R4	D	TO-220 (N.ISOL)
SC141C	Q4006R4	S	TO-220 (N.ISOL)
SC141D	Q4006R4	D	TO-220 (N.ISOL)
SC141E	Q5006R4	D	TO-220 (N.ISOL)
SC141M	Q6006R5	D	TO-220 (N.ISOL)
SC141N	Q8006R5	D	TO-220 (N.ISOL)
SC142B	Q2008L4	D	TO-220 (ISOL)
SC142D	Q4008L4	D	TO-220 (ISOL)
SC142E	Q5008L4	D	TO-220 (ISOL)
SC142M	Q6008L5	D	TO-220 (ISOL)
SC143B	Q2008R4	D	TO-220 (N.ISOL)
SC143D	Q4008R4	D	TO-220 (N.ISOL)
SC143E	Q5008R4	D	TO-220 (N.ISOL)
SC143M	Q6008R5	D	TO-220 (N.ISOL)
SC146B	Q2010R5	D	TO-220 (N.ISOL)
SC146D	Q4010R5	D	TO-220 (N.ISOL)
SC146E	Q5010R5	D	TO-220 (N.ISOL)
SC146M	Q6010R5	D	TO-220 (N.ISOL)
SC146N	Q8010R5	D	TO-220 (N.ISOL)
SC147B	Q2010L5	D	TO-220 (ISOL)
SC147D	Q4010L5	D	TO-220 (ISOL)
SC147E	Q5010L5	D	TO-220 (ISOL)
SC147M	Q6010L5	D	TO-220 (ISOL)
SC148B	Q2010L5	D	TO-220 (ISOL)
SC148D	Q4010L5	D	TO-220 (ISOL)
SC148E	Q5010L5	D	TO-220 (ISOL)
SC148M	Q6010L5	D	TO-220 (ISOL)
SC149B	Q2015R5	D	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
SC149D	Q4015R5	D	TO-220 (N.ISOL)
SC149E	Q5015R5	D	TO-220 (N.ISOL)
SC149M	Q6015R5	D	TO-220 (N.ISOL)
SC150B	Q2015L5	D	TO-220 (ISOL)
SC150D	Q4015L5	D	TO-220 (ISOL)
SC150E	Q5015L5	D	TO-220 (ISOL)
SC150M	Q6015L5	D	TO-220 (ISOL)
SC151B	Q2015R5	D	TO-220 (N.ISOL)
SC151D	Q4015R5	D	TO-220 (N.ISOL)
SC151E	Q5015R5	D	TO-220 (N.ISOL)
SC151M	Q6015R5	D	TO-220 (N.ISOL)
SC160B	Q2025P	S	FASTPAK (ISOL)
SC160D	Q4025P	S	FASTPAK (ISOL)
SC160E	Q5025P	S	FASTPAK (ISOL)
SC160M	Q6025P	S	FASTPAK (ISOL)
SC92A	Q201E3	D	TO-92 (ISOL)
SC92B	Q201E3	D	TO-92 (ISOL)
SC92D	Q401E3	D	TO-92 (ISOL)
SC92F	Q201E3	D	TO-92 (ISOL)
ST2	HT32	D	DO-35 (ISOL)
T0505MH	L6006L5	S	TO-220 (ISOL)
T0509MH	L6006L6	S	TO-220 (ISOL)
T0510DH	L4006L8	S	TO-220 (ISOL)
T0510MH	L6006L8	S	TO-220 (ISOL)
T0612BH	Q2006R4	D	TO-220 (N.ISOL)
T0612DH	Q4006R4	D	TO-220 (N.ISOL)
T0612MH	Q6006R5	D	TO-220 (N.ISOL)
T0805DH	L4008L6	S	TO-220 (ISOL)
T0805MH	L6008L6	S	TO-220 (ISOL)
T0809DH	L4008L8	S	TO-220 (ISOL)
T0809MH	L6008L8	S	TO-220 (ISOL)
T0810DH	Q4008R4	S	TO-220 (N.ISOL)
T0810MH	Q6008R5	S	TO-220 (N.ISOL)
T0810NH	Q8008R5	S	TO-220 (N.ISOL)
T0810SH	Q7008R5	S	TO-220 (N.ISOL)
T0812DH	Q4008R4	S	TO-220 (N.ISOL)
T0812MH	Q6008R5	S	TO-220 (N.ISOL)
T0812NH	Q8008R5	S	TO-220 (N.ISOL)
T0812SH	Q7008R5	S	TO-220 (N.ISOL)
T1010BH	Q2010R5	S	TO-220 (N.ISOL)
T1010BJ	Q2010L5	D	TO-220 (ISOL)
T1010DH	Q4010R5	S	TO-220 (N.ISOL)
T1010DJ	Q4010L5	D	TO-220 (ISOL)
T1010MH	Q6010R5	S	TO-220 (N.ISOL)
T1010MJ	Q6010L5	D	TO-220 (ISOL)
T1010NH	Q8010R5	S	TO-220 (N.ISOL)
T1010NJ	Q8010L5	D	TO-220 (ISOL)
T1012BH	Q2010R5	D	TO-220 (N.ISOL)
T1012BJ	Q2010L5	D	TO-220 (ISOL)
T1012DH	Q4010R5	D	TO-220 (N.ISOL)
T1012DJ	Q4010L5	D	TO-220 (ISOL)
T1012MH	Q6010R5	D	TO-220 (N.ISOL)
T1012MJ	Q6010L5	D	TO-220 (ISOL)
T1012NH	Q8010R5	S	TO-220 (N.ISOL)
T1012NJ	Q8010L5	S	TO-220 (ISOL)
T1013BH	Q2010R5	D	TO-220 (N.ISOL)
T1013BJ	Q2010L5	D	TO-220 (ISOL)
T1013DH	Q4010R5	D	TO-220 (N.ISOL)
T1013DJ	Q4010L5	D	TO-220 (ISOL)
T1013MH	Q6010R5	D	TO-220 (N.ISOL)
T1013MJ	Q6010L5	D	TO-220 (ISOL)
T1013NH	Q8010R5	D	TO-220 (N.ISOL)
T1013NJ	Q8010L5	D	TO-220 (ISOL)
T106A1SC	L2004F31	D	TO-202 (N.ISOL)
T106A1SD	L2004F51	D	TO-202 (N.ISOL)
T106A1SG	L2004F61	D	TO-202 (N.ISOL)
T106A1SH	L2004F81	D	TO-202 (N.ISOL)
T106A1SHA	Q2004F41	D	TO-202 (N.ISOL)
T106A1SS	L2004F31	D	TO-202 (N.ISOL)
T106A2SS	L2004F32	D	TO-202 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
T106B1SC	L2004F31	D	TO-202 (N.ISOL)
T106B1SD	L2004F51	D	TO-202 (N.ISOL)
T106B1SG	L2004F61	D	TO-202 (N.ISOL)
T106B1SGA	Q2004F31	D	TO-202 (N.ISOL)
T106B1SH	L2004F81	D	TO-202 (N.ISOL)
T106B1SHA	Q2004F41	D	TO-202 (N.ISOL)
T106B1SS	L2004F31	D	TO-202 (N.ISOL)
T106B2SD	L2004F52	D	TO-202 (N.ISOL)
T106B2SG	L2004F62	D	TO-202 (N.ISOL)
T106B2SGA	Q2004F32	D	TO-202 (N.ISOL)
T106B2SH	L2004F82	D	TO-202 (N.ISOL)
T106B2SHA	Q2004F42	D	TO-202 (N.ISOL)
T106B2SS	L2004F32	D	TO-202 (N.ISOL)
T106C1SC	L4004F31	D	TO-202 (N.ISOL)
T106C1SD	L4004F51	D	TO-202 (N.ISOL)
T106C1SG	L4004F61	D	TO-202 (N.ISOL)
T106C1SGA	Q4004F31	D	TO-202 (N.ISOL)
T106C1SH	L4004F81	D	TO-202 (N.ISOL)
T106C1SHA	Q4004F41	D	TO-202 (N.ISOL)
T106C1SS	L4004F31	D	TO-202 (N.ISOL)
T106C2SD	L4004F52	D	TO-202 (N.ISOL)
T106C2SG	L4004F62	D	TO-202 (N.ISOL)
T106C2SGA	Q4004F32	D	TO-202 (N.ISOL)
T106C2SH	L4004F82	D	TO-202 (N.ISOL)
T106C2SHA	Q4004F42	D	TO-202 (N.ISOL)
T106C2SS	L4004F32	D	TO-202 (N.ISOL)
T106D1SC	L4004F31	D	TO-202 (N.ISOL)
T106D1SD	L4004F51	D	TO-202 (N.ISOL)
T106D1SG	L4004F61	D	TO-202 (N.ISOL)
T106D1SGA	Q4004F31	D	TO-202 (N.ISOL)
T106D1SH	L4004F81	D	TO-202 (N.ISOL)
T106D1SHA	Q4004F41	D	TO-202 (N.ISOL)
T106D1SS	L4004F31	D	TO-202 (N.ISOL)
T106D2SD	L4004F52	D	TO-202 (N.ISOL)
T106D2SG	L4004F62	D	TO-202 (N.ISOL)
T106D2SGA	Q4004F32	D	TO-202 (N.ISOL)
T106D2SH	L4004F82	D	TO-202 (N.ISOL)
T106D2SHA	Q4004F42	D	TO-202 (N.ISOL)
T106D2SS	L4004F32	D	TO-202 (N.ISOL)
T106E1SC	L6004F31	D	TO-202 (N.ISOL)
T106E1SD	L6004F51	D	TO-202 (N.ISOL)
T106E1SG	L6004F61	D	TO-202 (N.ISOL)
T106E1SGA	Q5004F31	D	TO-202 (N.ISOL)
T106E1SH	L6004F81	D	TO-202 (N.ISOL)
T106E1SHA	Q5004F41	D	TO-202 (N.ISOL)
T106E1SS	L6004F31	D	TO-202 (N.ISOL)
T106E2SD	L6004F52	D	TO-202 (N.ISOL)
T106E2SG	L6004F62	D	TO-202 (N.ISOL)
T106E2SGA	Q5004F32	D	TO-202 (N.ISOL)
T106E2SH	L6004F82	D	TO-202 (N.ISOL)
T106E2SHA	Q5004F42	D	TO-202 (N.ISOL)
T106E2SS	L4004F32	D	TO-202 (N.ISOL)
T106F1SC	L2004F31	D	TO-202 (N.ISOL)
T106F1SD	L2004F51	D	TO-202 (N.ISOL)
T106F1SG	L2004F61	D	TO-202 (N.ISOL)
T106F1SGA	Q2004F31	D	TO-202 (N.ISOL)
T106F1SH	L2004F81	D	TO-202 (N.ISOL)
T106F1SHA	Q2004F41	D	TO-202 (N.ISOL)
T106F1SS	L2004F31	D	TO-202 (N.ISOL)
T106F2SC	L2004F32	D	TO-202 (N.ISOL)
T106F2SD	L2004F52	D	TO-202 (N.ISOL)
T106F2SG	L2004F62	D	TO-202 (N.ISOL)
T106F2SGA	Q2004F32	D	TO-202 (N.ISOL)
T106F2SH	L2004F82	D	TO-202 (N.ISOL)
T106F2SHA	Q2004F42	D	TO-202 (N.ISOL)
T106F2SS	L2004F32	D	TO-202 (N.ISOL)
T106M1SD	L6004F51	D	TO-202 (N.ISOL)
T106M1SG	L6004F61	D	TO-202 (N.ISOL)
T106M1SGA	Q6004F31	D	TO-202 (N.ISOL)
T106M1SH	L6004F81	D	TO-202 (N.ISOL)

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Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
T106M1SHA	Q6004F41	D	TO-202 (N.ISOL)
T106M1SS	L6004F31	D	TO-202 (N.ISOL)
T106M2SD	L6004F52	D	TO-202 (N.ISOL)
T106M2SG	L6004F62	D	TO-202 (N.ISOL)
T106M2SGA	Q6004F32	D	TO-202 (N.ISOL)
T106M2SH	L6004F82	D	TO-202 (N.ISOL)
T106M2SHA	Q6004F42	D	TO-202 (N.ISOL)
T106M2SS	L6004F32	D	TO-202 (N.ISOL)
T1210BH	Q2015R5	S	TO-220 (N.ISOL)
T1210DH	Q4015R5	S	TO-220 (N.ISOL)
T1210MH	Q6015R5	S	TO-220 (N.ISOL)
T1210NH	Q8015R5	S	TO-220 (N.ISOL)
T1212BH	Q2015R5	D	TO-220 (N.ISOL)
T1212BJ	Q4015L5	D	TO-220 (ISOL)
T1212DH	Q4015R5	D	TO-220 (N.ISOL)
T1212DJ	Q4015L5	D	TO-220 (ISOL)
T1212MH	Q6015R5	D	TO-220 (N.ISOL)
T1212MJ	Q6015L5	D	TO-220 (ISOL)
T1212NH	Q8015R5	D	TO-220 (N.ISOL)
T1212NJ	Q8015L5	D	TO-220 (ISOL)
T1213BH	Q2015R5	D	TO-220 (N.ISOL)
T1213BJ	Q4015L5	D	TO-220 (ISOL)
T1213DH	Q4015R5	D	TO-220 (N.ISOL)
T1213DJ	Q4015L5	D	TO-220 (ISOL)
T1213MH	Q6015R5	D	TO-220 (N.ISOL)
T1213MJ	Q6015L5	D	TO-220 (ISOL)
T1213NH	Q8015R5	D	TO-220 (N.ISOL)
T1213NJ	Q8015L5	D	TO-220 (ISOL)
T1512BJ	Q2015L5	D	TO-220 (ISOL)
T1512DJ	Q4015L5	D	TO-220 (ISOL)
T1512MJ	Q6015L5	D	TO-220 (ISOL)
T1512NJ	Q8015L5	D	TO-220 (ISOL)
T1513BJ	Q2015L5	D	TO-220 (ISOL)
T1513DJ	Q4015L5	D	TO-220 (ISOL)
T1513MJ	Q6015L5	D	TO-220 (ISOL)
T1513NJ	Q8015L5	D	TO-220 (ISOL)
T1612BH	Q2015R5	D	TO-220 (N.ISOL)
T1612DH	Q4015R5	D	TO-220 (N.ISOL)
T1612MH	Q6015R5	D	TO-220 (N.ISOL)
T1612NH	Q8015R5	D	TO-220 (N.ISOL)
T1612NJ	Q8015L5	S	TO-220 (ISOL)
T1613BH	Q2015R5	D	TO-220 (N.ISOL)
T1613DH	Q4015R5	D	TO-220 (N.ISOL)
T1613MH	Q6015R5	D	TO-220 (N.ISOL)
T1613NH	Q8015R	S	TO-220 (N.ISOL)
T2300A	L2004F321	S	TO-202 (N.ISOL)
T2300B	L2004F321	S	TO-202 (N.ISOL)
T2300D	L4004F321	S	TO-202 (N.ISOL)
T2300F	L2004F321	S	TO-202 (N.ISOL)
T2300PA	L2004F31	S	TO-202 (N.ISOL)
T2300PB	L2004F31	S	TO-202 (N.ISOL)
T2300PC	L4004F31	S	TO-202 (N.ISOL)
T2300PD	L4004F31	S	TO-202 (N.ISOL)
T2300PE	L6004F31	S	TO-202 (N.ISOL)
T2300PF	L2004F31	S	TO-202 (N.ISOL)
T2300PM	L6004F31	S	TO-202 (N.ISOL)
T2301A	L2004F321	S	TO-202 (N.ISOL)
T2301B	L2004F321	S	TO-202 (N.ISOL)
T2301D	L4004F321	S	TO-202 (N.ISOL)
T2301F	L2004F321	S	TO-202 (N.ISOL)
T2301PA	L2004F31	S	TO-202 (N.ISOL)
T2301PB	L2004F31	S	TO-202 (N.ISOL)
T2301PC	L4004F31	S	TO-202 (N.ISOL)
T2301PD	L4004F31	S	TO-202 (N.ISOL)
T2301PE	L6004F31	S	TO-202 (N.ISOL)
T2301PF	L2004F31	S	TO-202 (N.ISOL)
T2301PM	L6004F31	S	TO-202 (N.ISOL)
T2302A	L2004F621	S	TO-202 (N.ISOL)
T2302B	L2004F621	S	TO-202 (N.ISOL)
T2302D	L4004F621	S	TO-202 (N.ISOL)
T2302F	L2004F621	S	TO-202 (N.ISOL)
T2302PA	L2004F61	S	TO-202 (N.ISOL)
T2302PB	L2004F61	S	TO-202 (N.ISOL)
T2302PC	L4004F61	S	TO-202 (N.ISOL)
T2302PD	L4004F61	S	TO-202 (N.ISOL)
T2302PE	L6004F61	S	TO-202 (N.ISOL)
T2302PF	L2004F61	S	TO-202 (N.ISOL)
T2302PM	L6004F61	S	TO-202 (N.ISOL)
T2303F	Q2004F421	S	TO-202 (N.ISOL)
T2306A	Q2004F421	S	TO-202 (N.ISOL)
T2306B	Q2004F421	S	TO-202 (N.ISOL)
T2306D	Q4004F421	S	TO-202 (N.ISOL)
T2310A	L2004F321	S	TO-202 (N.ISOL)
T2310B	L2004F321	S	TO-202 (N.ISOL)
T2310D	L4004F321	S	TO-202 (N.ISOL)
T2310F	L2004F321	S	TO-202 (N.ISOL)
T2311A	L2004F321	S	TO-202 (N.ISOL)
T2311B	L2004F321	S	TO-202 (N.ISOL)
T2311D	L4004F321	S	TO-202 (N.ISOL)
T2311F	L2004F321	S	TO-202 (N.ISOL)
T2312A	L2004F621	S	TO-202 (N.ISOL)
T2312B	L2004F621	S	TO-202 (N.ISOL)
T2312D	L4004F621	S	TO-202 (N.ISOL)
T2312F	L2004F621	S	TO-202 (N.ISOL)
T2313A	Q2004F421	S	TO-202 (N.ISOL)
T2313B	Q2004F421	S	TO-202 (N.ISOL)
T2313D	Q4004F421	S	TO-202 (N.ISOL)
T2313F	Q2004F421	S	TO-202 (N.ISOL)
T2316A	Q2004F421	S	TO-202 (N.ISOL)
T2316B	Q2004F421	S	TO-202 (N.ISOL)
T2316D	Q4004F421	S	TO-202 (N.ISOL)
T2320A	L2004F31	D	TO-202 (N.ISOL)
T2320B	L2004F31	D	TO-202 (N.ISOL)
T2320C	L4004F31	D	TO-202 (N.ISOL)
T2320D	L4004F31	D	TO-202 (N.ISOL)
T2320E	L6004F31	D	TO-202 (N.ISOL)
T2320F	L2004F31	D	TO-202 (N.ISOL)
T2320M	L6004F31	D	TO-202 (N.ISOL)
T2322A	L2004F61	D	TO-202 (N.ISOL)
T2322B	L2004F61	D	TO-202 (N.ISOL)
T2322C	L4004F61	D	TO-202 (N.ISOL)
T2322D	L4004F61	D	TO-202 (N.ISOL)
T2322E	L6004F61	D	TO-202 (N.ISOL)
T2322F	L2004F61	D	TO-202 (N.ISOL)
T2322M	L6004F61	D	TO-202 (N.ISOL)
T2323A	L2004F81	D	TO-202 (N.ISOL)
T2323B	L2004F81	D	TO-202 (N.ISOL)
T2323C	L4004F81	D	TO-202 (N.ISOL)
T2323D	L4004F81	D	TO-202 (N.ISOL)
T2323E	L6004F81	D	TO-202 (N.ISOL)
T2323F	L2004F81	D	TO-202 (N.ISOL)
T2323M	L6004F81	D	TO-202 (N.ISOL)
T2327A	L2004F51	D	TO-202 (N.ISOL)
T2327B	L2004F51	D	TO-202 (N.ISOL)
T2327C	L4004F51	D	TO-202 (N.ISOL)
T2327D	L4004F51	D	TO-202 (N.ISOL)
T2327E	L6004F51	D	TO-202 (N.ISOL)
T2327F	L2004F51	D	TO-202 (N.ISOL)
T2327M	L6004F51	D	TO-202 (N.ISOL)
T2500A	Q2006R4	D	TO-220 (N.ISOL)
T2500AFP	Q2006L4	D	TO-220 (ISOL)
T2500B	Q2006R4	D	TO-220 (N.ISOL)
T2500BFP	Q2006L4	D	TO-220 (ISOL)
T2500C	Q4006R4	D	TO-220 (N.ISOL)
T2500CFP	Q4006L4	D	TO-220 (ISOL)
T2500D	Q4006R4	D	TO-220 (N.ISOL)
T2500DFP	Q4006L4	D	TO-220 (ISOL)
T2500E	Q5006R4	D	TO-220 (N.ISOL)
T2500EFP	Q5006L4	D	TO-220 (ISOL)
T2500M	Q6006R5	D	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
T2500MFP	Q6006L5	D	TO-220 (ISOL)
T2500N	Q8006R5	D	TO-220 (N.ISOL)
T2500NFP	Q8006L5	D	TO-220 (ISOL)
T2500S	Q7006R5	D	TO-220 (N.ISOL)
T2500SFP	Q7006L5	D	TO-220 (ISOL)
T2506B	Q2006R4	D	TO-220 (N.ISOL)
T2506D	Q4006R4	D	TO-220 (N.ISOL)
T2512BH	Q2025R5	S	TO-220 (N.ISOL)
T2512BK	Q2025P	S	FASTPAK (ISOL)
T2512DH	Q4025R5	S	TO-220 (N.ISOL)
T2512DK	Q4025P	S	FASTPAK (ISOL)
T2512MH	Q6025R5	S	TO-220 (N.ISOL)
T2512MK	Q6025P	S	FASTPAK (ISOL)
T2512NH	Q8025R5	S	TO-220 (N.ISOL)
T2512NK	Q8025P	S	FASTPAK (ISOL)
T2513BH	Q2025R5	S	TO-220 (N.ISOL)
T2513BK	Q2025P	S	FASTPAK (ISOL)
T2513DH	Q4025R5	S	TO-220 (N.ISOL)
T2513DK	Q4025P	S	FASTPAK (ISOL)
T2513MH	Q6025R5	S	TO-220 (N.ISOL)
T2513MK	Q6025P	S	FASTPAK (ISOL)
T2513NH	Q8025R5	S	TO-220 (N.ISOL)
T2513NH	Q8025R5	S	TO-220 (N.ISOL)
T2513NK	Q8025P	S	FASTPAK (ISOL)
T2700B	Q2006R4	S	TO-220 (N.ISOL)
T2700D	Q4006R4	S	TO-220 (N.ISOL)
T2800A	Q2008R4	S	TO-220 (N.ISOL)
T2800B	Q2008R4	S	TO-220 (N.ISOL)
T2800C	Q4008R4	S	TO-220 (N.ISOL)
T2800D	Q4008R4	S	TO-220 (N.ISOL)
T2800E	Q5008R4	S	TO-220 (N.ISOL)
T2800M	Q6008R5	S	TO-220 (N.ISOL)
T2801A	Q2006R4	D	TO-220 (N.ISOL)
T2801B	Q2006R4	D	TO-220 (N.ISOL)
T2801C	Q4006R4	D	TO-220 (N.ISOL)
T2801D	Q4006R4	D	TO-220 (N.ISOL)
T2801E	Q5006R4	D	TO-220 (N.ISOL)
T2801M	Q6006R5	D	TO-220 (N.ISOL)
T2801N	Q8006R5	D	TO-220 (N.ISOL)
T2801S	Q7006R5	D	TO-220 (N.ISOL)
T2802A	Q2008R4	S	TO-220 (N.ISOL)
T2802B	Q2008R4	S	TO-220 (N.ISOL)
T2802C	Q4008R4	S	TO-220 (N.ISOL)
T2802D	Q4008R4	S	TO-220 (N.ISOL)
T2802E	Q5008R4	S	TO-220 (N.ISOL)
T2802M	Q6008R5	S	TO-220 (N.ISOL)
T2806B	Q2008R4	D	TO-220 (N.ISOL)
T2806D	Q4008R4	D	TO-220 (N.ISOL)
T2806M	Q6008R5	S	TO-220 (N.ISOL)
T2850A	Q2008L4	D	TO-220 (ISOL)
T2850B	Q2008L4	D	TO-220 (ISOL)
T2850D	Q4008L4	D	TO-220 (ISOL)
T2850E	Q5008L4	D	TO-220 (ISOL)
T2850F	Q2008L4	D	TO-220 (ISOL)
T2856B	Q2008L4	D	TO-220 (ISOL)
T2856D	Q4008L4	D	TO-220 (ISOL)
T4012DKS	Q4040P	S	FASTPAK (ISOL)
T4012MKS	Q6040P	S	FASTPAK (ISOL)
T4012NKS	Q8040P	S	FASTPAK (ISOL)
T4012SKS	Q7040P	S	FASTPAK (ISOL)
T4013DKS	Q4040P	S	FASTPAK (ISOL)
T4013MKS	Q6040P	S	FASTPAK (ISOL)
T4013NKS	Q8040P	S	FASTPAK (ISOL)
T4013SKS	Q7040P	S	FASTPAK (ISOL)
T6000B	Q2015R5	D	TO-220 (N.ISOL)
T6000D	Q4015R5	D	TO-220 (N.ISOL)
T6000M	Q6015R5	D	TO-220 (N.ISOL)
T6001B	Q2015R5	D	TO-220 (N.ISOL)
T6001D	Q4015R5	D	TO-220 (N.ISOL)
T6001M	Q6015R5	D	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
T6006B	Q2015R5	S	TO-220 (N.ISOL)
T6006D	Q4015R5	S	TO-220 (N.ISOL)
T6006M	Q6015R5	S	TO-220 (N.ISOL)
TL1003	S1006F2	S	TO-202 (N.ISOL)
TL1006	S1006F2	S	TO-202 (N.ISOL)
TL106-05	T106F2	D	TO-202 (N.ISOL)
TL106-1	T106A2	D	TO-202 (N.ISOL)
TL106-2	T106B2	D	TO-202 (N.ISOL)
TL106-4	T106D2	D	TO-202 (N.ISOL)
TL106-6	T106M2	D	TO-202 (N.ISOL)
TL107-05	T107F2	D	TO-202 (N.ISOL)
TL107-1	T107A2	D	TO-202 (N.ISOL)
TL107-2	T107B2	D	TO-202 (N.ISOL)
TL107-4	T107D2	D	TO-202 (N.ISOL)
TL107-6	T107M2	D	TO-202 (N.ISOL)
TL2003	S2006F2	S	TO-202 (N.ISOL)
TL2006	S2006F2	S	TO-202 (N.ISOL)
TL4003	S4006F2	S	TO-202 (N.ISOL)
TL4006	S4006F2	S	TO-202 (N.ISOL)
TL6003	S6006F2	S	TO-202 (N.ISOL)
TL6006	S6006F2	S	TO-202 (N.ISOL)
TLC111A	L2004F62	D	TO-202 (N.ISOL)
TLC111B	Q2004F42	D	TO-202 (N.ISOL)
TLC111D	L2004F52	D	TO-202 (N.ISOL)
TLC111S	L2004F62	D	TO-202 (N.ISOL)
TLC111T	L2004F52	D	TO-202 (N.ISOL)
TLC113B	Q2004F42	D	TO-202 (N.ISOL)
TLC1165	L2004F62	D	TO-202 (N.ISOL)
TLC116A	L2004F62	D	TO-202 (N.ISOL)
TLC116B	Q2004F42	D	TO-202 (N.ISOL)
TLC116D	L2004F52	D	TO-202 (N.ISOL)
TLC116T	L2004F52	D	TO-202 (N.ISOL)
TLC221A	L4004F62	D	TO-202 (N.ISOL)
TLC221B	Q4004F42	D	TO-202 (N.ISOL)
TLC221D	L4004F52	D	TO-202 (N.ISOL)
TLC221S	L4004F62	D	TO-202 (N.ISOL)
TLC221T	L4004F52	D	TO-202 (N.ISOL)
TLC223A	L4004F62	D	TO-202 (N.ISOL)
TLC223B	Q4004F42	D	TO-202 (N.ISOL)
TLC223D	L4004F52	D	TO-202 (N.ISOL)
TLC226A	L4004F62	D	TO-202 (N.ISOL)
TLC226B	Q4004F42	D	TO-202 (N.ISOL)
TLC226D	L4004F52	D	TO-202 (N.ISOL)
TLC226S	L4004F62	D	TO-202 (N.ISOL)
TLC226T	L4004F52	D	TO-202 (N.ISOL)
TLC331A	L6004F62	D	TO-202 (N.ISOL)
TLC331B	Q6004F42	D	TO-202 (N.ISOL)
TLC331D	L6004F52	D	TO-202 (N.ISOL)
TLC331S	L6004F62	D	TO-202 (N.ISOL)
TLC331T	L6004F52	D	TO-202 (N.ISOL)
TLC333A	L6004F62	D	TO-202 (N.ISOL)
TLC333B	Q6004F42	D	TO-202 (N.ISOL)
TLC333D	L6004F52	D	TO-202 (N.ISOL)
TLC336A	L6004F62	D	TO-202 (N.ISOL)
TLC336B	Q6004F42	D	TO-202 (N.ISOL)
TLC336D	L6004F52	D	TO-202 (N.ISOL)
TLC336S	L6004F62	D	TO-202 (N.ISOL)
TLC336T	L6004F52	D	TO-202 (N.ISOL)
TLC386B	Q7004F42	D	TO-202 (N.ISOL)
TLS106-05	T106F2	D	TO-202 (N.ISOL)
TLS106-1	T106A2	D	TO-202 (N.ISOL)
TLS106-2	T106B2	D	TO-202 (N.ISOL)
TLS106-4	T106D2	D	TO-202 (N.ISOL)
TLS106-6	T106M2	D	TO-202 (N.ISOL)
TLS107-05	T107F2	D	TO-202 (N.ISOL)
TLS107-1	T107A2	D	TO-202 (N.ISOL)
TLS107-2	T107B2	D	TO-202 (N.ISOL)
TLS107-4	T107D2	D	TO-202 (N.ISOL)
TLS107-6	T107M2	D	TO-202 (N.ISOL)
TO1013BJ	Q2010L5	D	TO-220 (ISOL)

Cross Reference Guide

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
TO1013DJ	Q4010L5	D	TO-220 (ISOL)
TO1013MJ	Q6010L5	D	TO-220 (ISOL)
TO1013NJ	Q8010L5	D	TO-220 (ISOL)
TO409BJ	L2004L6	D	TO-220 (ISOL)
TO409DJ	L4004L6	D	TO-220 (ISOL)
TO409MJ	L6004L6	D	TO-220 (ISOL)
TO410BJ	L2004L8	D	TO-220 (ISOL)
TO410DJ	L4004L8	D	TO-220 (ISOL)
TO410MJ	L6004L8	D	TO-220 (ISOL)
TO505BH	L2006L5	S	TO-220 (ISOL)
TO505DH	L4006L5	S	TO-220 (ISOL)
TO509BH	L2006L6	S	TO-220 (ISOL)
TO509DH	L2006L6	S	TO-220 (ISOL)
TO510BH	L2006L8	S	TO-220 (ISOL)
TO512BH	Q2006R4	D	TO-220 (N.ISOL)
TO512DH	Q4006R4	D	TO-220 (N.ISOL)
TO512MH	Q6006R5	S	TO-220 (N.ISOL)
TO605BH	L2006L5	S	TO-220 (ISOL)
TO605DH	L4006L5	S	TO-220 (ISOL)
TO605MH	L6006L5	S	TO-220 (ISOL)
TO609BH	L2006L6	S	TO-220 (ISOL)
TO609BJ	L2006L6	D	TO-220 (ISOL)
TO609DH	L4006L6	S	TO-220 (ISOL)
TO609DJ	L4006L6	D	TO-220 (ISOL)
TO609MH	L6006L6	S	TO-220 (ISOL)
TO609MJ	L6006L6	D	TO-220 (ISOL)
TO610BH	L2006L8	S	TO-220 (ISOL)
TO610BJ	L2006L8	D	TO-220 (ISOL)
TO610DH	L4006L8	S	TO-220 (ISOL)
TO610DJ	L4006L8	D	TO-220 (ISOL)
TO610MH	L6006L8	S	TO-220 (ISOL)
TO610MJ	L6006L8	D	TO-220 (ISOL)
TO612BJ	Q2006L4	S	TO-220 (ISOL)
TO612DJ	Q4006L4	S	TO-220 (ISOL)
TO612MJ	Q6006L5	S	TO-220 (ISOL)
TO805BH	L2008L6	S	TO-220 (ISOL)
TO805DH	L4008L6	S	TO-220 (ISOL)
TO805MH	L6008L6	S	TO-220 (ISOL)
TO809BH	L2008L6	S	TO-220 (ISOL)
TO809DH	L4008L6	S	TO-220 (ISOL)
TO809MH	L6008L6	S	TO-220 (ISOL)
TO810BH	L2008L8	S	TO-220 (ISOL)
TO810BJ	L2008L8	D	TO-220 (ISOL)
TO810DH	L4008L8	S	TO-220 (ISOL)
TO810DJ	L4008L8	D	TO-220 (ISOL)
TO810MH	L6008L8	S	TO-220 (ISOL)
TO810MJ	L6008L8	D	TO-220 (ISOL)
TO812BH	Q2008R4	S	TO-220 (N.ISOL)
TO812BJ	Q2008L4	S	TO-220 (ISOL)
TO812DH	Q4008R4	S	TO-220 (N.ISOL)
TO812DJ	Q4008L4	S	TO-220 (ISOL)
TO812MH	Q6008R5	S	TO-220 (N.ISOL)
TO812MJ	Q6008L5	S	TO-220 (ISOL)
TO812NH	Q8008L5	S	TO-220 (ISOL)
TO813BJ	Q2008L4	S	TO-220 (ISOL)
TO813DJ	Q4008L4	S	TO-220 (ISOL)
TO813MJ	Q6008L5	S	TO-220 (ISOL)
TO813NJ	Q8008L5	S	TO-220 (ISOL)
TPDV-440	Q4040J7	D	TO-218 (ISOL)
TPDV-640	Q6040K7	D	TO-218 (ISOL)
TPDV-840	Q8040K7	D	TO-218 (ISOL)
TPDV125	Q2025L6	S	TO-220 (ISOL)
TPDV140	Q2040K7	D	TO-218 (ISOL)
TPDV225	Q2025L6	S	TO-220 (ISOL)
TPDV240	Q2040K7	D	TO-218 (ISOL)
TPDV425	Q4025L6	S	TO-220 (ISOL)
TPDV625	Q6025L6	S	TO-220 (ISOL)
TPDV825	Q8025L6	S	TO-220 (ISOL)
TXDV-212	Q2015L6	D	TO-220 (ISOL)
TXDV-412	Q4015L6	D	TO-220 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
TXDV612	Q6015L6	D	TO-220 (ISOL)
TXDV812	Q8015L6	D	TO-220 (ISOL)
TXN0510	S0510L	D	TO-220 (ISOL)
TXN0512	S0515L	S	TO-220 (ISOL)
TXN056	S0506L	D	TO-220 (ISOL)
TXN058	S0508L	D	TO-220 (ISOL)
TXN058G	S0508L	D	TO-220 (ISOL)
TXN106	S1006L	D	TO-220 (ISOL)
TXN108	S1008L	D	TO-220 (ISOL)
TXN108G	S1008L	D	TO-220 (ISOL)
TXN110	S1010L	D	TO-220 (ISOL)
TXN112	S1015L	S	TO-220 (ISOL)
TXN204	S2006L	S	TO-220 (ISOL)
TXN206	S2006L	D	TO-220 (ISOL)
TXN208	S2008L	D	TO-220 (ISOL)
TXN208G	S2008L	D	TO-220 (ISOL)
TXN210	S2010L	D	TO-220 (ISOL)
TXN212	S2015L	S	TO-220 (ISOL)
TXN404	S4006L	S	TO-220 (ISOL)
TXN406	S4006L	D	TO-220 (ISOL)
TXN408	S4008L	D	TO-220 (ISOL)
TXN408G	S4008L	D	TO-220 (ISOL)
TXN410	S4010L	D	TO-220 (ISOL)
TXN412	S4015L	S	TO-220 (ISOL)
TXN604	S6006L	S	TO-220 (ISOL)
TXN606	S6006L	D	TO-220 (ISOL)
TXN608	S6008L	D	TO-220 (ISOL)
TXN608G	S6008L	D	TO-220 (ISOL)
TXN610	S6010L	D	TO-220 (ISOL)
TXN612	S6015L	S	TO-220 (ISOL)
TYN0510	S0510R	D	TO-220 (N.ISOL)
TYN0512	S0512R	D	TO-220 (N.ISOL)
TYN0516	S0516R	D	TO-220 (N.ISOL)
TYN054	S0506F1	S	TO-202 (N.ISOL)
TYN056	S0506F1	S	TO-202 (N.ISOL)
TYN058	S0508R	D	TO-220 (N.ISOL)
TYN058G	S0508R	S	TO-220 (N.ISOL)
TYN058K	S0508R	S	TO-220 (N.ISOL)
TYN104	S1006F1	S	TO-202 (N.ISOL)
TYN106	S1006F1	S	TO-202 (N.ISOL)
TYN108	S1008R	D	TO-220 (N.ISOL)
TYN108G	S1008R	S	TO-220 (N.ISOL)
TYN110	S1010R	D	TO-220 (N.ISOL)
TYN112	S1012R	D	TO-220 (N.ISOL)
TYN116	S1016R	D	TO-220 (N.ISOL)
TYN204	S2006F1	S	TO-202 (N.ISOL)
TYN206	S2006F1	S	TO-202 (N.ISOL)
TYN208	S2008R	D	TO-220 (N.ISOL)
TYN208G	S2008R	S	TO-220 (N.ISOL)
TYN208K	S2008R	S	TO-220 (N.ISOL)
TYN210	S2010R	D	TO-220 (N.ISOL)
TYN212	S2012R	D	TO-220 (N.ISOL)
TYN216	S2016R	D	TO-220 (N.ISOL)
TYN404	S4006F1	S	TO-202 (N.ISOL)
TYN406	S4006F1	S	TO-202 (N.ISOL)
TYN408	S4008R	D	TO-220 (N.ISOL)
TYN408G	S4008R	S	TO-220 (N.ISOL)
TYN408K	S4008R	S	TO-220 (N.ISOL)
TYN410	S4010R	D	TO-220 (N.ISOL)
TYN412	S4012R	D	TO-220 (N.ISOL)
TYN416	S4016R	D	TO-220 (N.ISOL)
TYN604	S6006F1	S	TO-202 (N.ISOL)
TYN606	S6006F1	S	TO-202 (N.ISOL)
TYN608	S6008R	D	TO-220 (N.ISOL)
TYN608G	S6008R	S	TO-220 (N.ISOL)
TYN608K	S6008R	S	TO-220 (N.ISOL)
TYN610	S6010R	D	TO-220 (N.ISOL)
TYN612	S6012R	D	TO-220 (N.ISOL)
TYN616	S6016R	D	TO-220 (N.ISOL)
TYN682	S0525R	D	TO-220 (N.ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
TYN683	S1025R	D	TO-220 (N.ISOL)
TYN685	S2025R	D	TO-220 (N.ISOL)
TYN688	S4025R	D	TO-220 (N.ISOL)
TYN690	S6025R	D	TO-220 (N.ISOL)
TYN808	S8008R	D	TO-220 (N.ISOL)
TYN808G	S8008R	S	TO-220 (N.ISOL)
TYN808K	S8008R	S	TO-220 (N.ISOL)
TYN810	S8010R	S	TO-220 (N.ISOL)
TYN812	S8012R	D	TO-220 (N.ISOL)
TYN816	S8016R	D	TO-220 (N.ISOL)
TYS1006-05	S0510LS2	S	TO-220 (ISOL)
TYS1006-1	S1010LS2	S	TO-220 (ISOL)
TYS1006-2	S2010LS2	S	TO-220 (ISOL)
TYS1006-4	S2010LS2	S	TO-220 (ISOL)
TYS1007-05	S0510LS3	S	TO-220 (ISOL)
TYS1007-1	S1010LS3	S	TO-220 (ISOL)
TYS1007-2	S4010LS3	S	TO-220 (ISOL)
TYS1007-4	S4010LS3	S	TO-220 (ISOL)
TYS406-05	T106F1	S	TO-202 (N.ISOL)
TYS406-1	T106A1	S	TO-202 (N.ISOL)
TYS406-2	T106B1	S	TO-202 (N.ISOL)
TYS406-4	T106D1	S	TO-202 (N.ISOL)
TYS406-6	T106M1	S	TO-202 (N.ISOL)
TYS407-05	T107F1	S	TO-202 (N.ISOL)
TYS407-1	T107A1	S	TO-202 (N.ISOL)
TYS407-2	T107B1	S	TO-202 (N.ISOL)
TYS407-4	T107D1	S	TO-202 (N.ISOL)
TYS407-6	T107M1	S	TO-202 (N.ISOL)
TYS606-05	S0506LS2	D	TO-220 (ISOL)
TYS606-1	S1006LS2	D	TO-220 (ISOL)
TYS606-2	S2006LS2	D	TO-220 (ISOL)
TYS606-4	S4006LS2	D	TO-220 (ISOL)
TYS606-6	S6006LS2	S	TO-220 (ISOL)
TYS607-05	S0506LS3	D	TO-220 (ISOL)
TYS607-1	S1006LS3	D	TO-220 (ISOL)
TYS607-2	S2006LS3	D	TO-220 (ISOL)
TYS607-4	S4006LS3	D	TO-220 (ISOL)
TYS607-6	S6006LS3	S	TO-220 (ISOL)
TYS806-05	S0508LS2	D	TO-220 (ISOL)
TYS806-1	S1008LS2	D	TO-220 (ISOL)
TYS806-2	S2008LS2	D	TO-220 (ISOL)
TYS806-4	S4008LS2	D	TO-220 (ISOL)
TYS806-6	S6008LS2	S	TO-220 (ISOL)
TYS807-05	S0508LS3	D	TO-220 (ISOL)
TYS807-1	S1008LS3	D	TO-220 (ISOL)
TYS807-2	S2008LS3	D	TO-220 (ISOL)
TYS807-4	S4008LS3	D	TO-220 (ISOL)
TYS807-6	S6008LS3	S	TO-220 (ISOL)
X0101BA	EC103B1	S	TO-92 (ISOL)
X0101DA	EC103D1	S	TO-92 (ISOL)
X0101MA	EC103M1	S	TO-92 (ISOL)
X0102BA	EC103B	S	TO-92 (ISOL)
X0102DA	EC103D	S	TO-92 (ISOL)
X0102MA	EC103M	S	TO-92 (ISOL)
X0103BA	EC103B	D	TO-92 (ISOL)
X0103BA	EC103B	S	TO-92 (ISOL)
X0103DA	EC103D	S	TO-92 (ISOL)
X0103MA	EC103M	S	TO-92 (ISOL)
X0104BA	EC103B2	D	TO-92 (ISOL)
X0104DA	EC103D2	D	TO-92 (ISOL)
X0104MA	EC103M2	D	TO-92 (ISOL)
X0105BA	EC103B2	S	TO-92 (ISOL)
X0105DA	EC103D2	S	TO-92 (ISOL)
X0105MA	EC103M2	S	TO-92 (ISOL)
X0106BA	EC103B	S	TO-92 (ISOL)
X0106DA	EC103D	S	TO-92 (ISOL)
X0106MA	EC103M	S	TO-92 (ISOL)
X0110BA	EC103B1	S	TO-92 (ISOL)
X0110DA	EC103D1	S	TO-92 (ISOL)
X0110MA	EC103M1	S	TO-92 (ISOL)

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
X0202BA	TCR22-4	D	TO-92 (ISOL)
X0202DA	TCR22-6	D	TO-92 (ISOL)
X0202MA	TCR22-8	D	TO-92 (ISOL)
X0203BA	TCR22-4	S	TO-92 (ISOL)
X0203DA	TCR22-6	S	TO-92 (ISOL)
X0203MA	TCR22-8	S	TO-92 (ISOL)
X0204BA	TCR22-4	S	TO-92 (ISOL)
X0204DA	TCR22-6	S	TO-92 (ISOL)
X0204MA	TCR22-8	S	TO-92 (ISOL)
X0205BA	EC103B2	S	TO-92 (ISOL)
X0205DA	EC103D2	S	TO-92 (ISOL)
X0205MA	EC103M2	S	TO-92 (ISOL)
X0206BA	TCR22-4	S	TO-92 (ISOL)
X0206DA	TCR22-6	S	TO-92 (ISOL)
X0402BE	T106B1	D	TO-202 (N.ISOL)
X0402BF	T106B2	D	TO-202 (N.ISOL)
X0402DE	T106D1	D	TO-202 (N.ISOL)
X0402DF	T106D2	D	TO-202 (N.ISOL)
X0402DG	T106D1	S	TO-202 (N.ISOL)
X0402ME	T106M1	D	TO-202 (N.ISOL)
X0402MF	T106M2	D	TO-202 (N.ISOL)
X0403BE	T106B1	S	TO-202 (N.ISOL)
X0403BF	T106B2	S	TO-202 (N.ISOL)
X0403DE	T106D1	S	TO-202 (N.ISOL)
X0403DF	T106D2	S	TO-202 (N.ISOL)
X0403ME	T106M1	S	TO-202 (N.ISOL)
X0403MF	T106M2	S	TO-202 (N.ISOL)
X0405BE	T106B1	S	TO-202 (N.ISOL)
X0405BF	T106B2	S	TO-202 (N.ISOL)
X0405DE	T106D1	S	TO-202 (N.ISOL)
X0405DF	T106D2	S	TO-202 (N.ISOL)
X0405ME	T106M1	S	TO-202 (N.ISOL)
X0405MF	T106M2	S	TO-202 (N.ISOL)
Z0102BA	L201E3	D	TO-92 (ISOL)
Z0102DA	L401E3	D	TO-92 (ISOL)
Z0102MA	L601E3	D	TO-92 (ISOL)
Z0105BA	L201E5	D	TO-92 (ISOL)
Z0105DA	L401E5	D	TO-92 (ISOL)
Z0105MA	L601E5	D	TO-92 (ISOL)
Z0109BA	L201E6	D	TO-92 (ISOL)
Z0109DA	L401E6	D	TO-92 (ISOL)
Z0109MA	L601E6	D	TO-92 (ISOL)
Z0110BA	L201E8	D	TO-92 (ISOL)
Z0110DA	L401E8	D	TO-92 (ISOL)
Z0110MA	L601E8	D	TO-92 (ISOL)
Z0302BG	L2004F321	S	TO-202 (N.ISOL)
Z0302DG	L4004F321	S	TO-202 (N.ISOL)
Z0302MG	L6004L3	S	TO-220 (ISOL)
Z0305BG	L2004F521	S	TO-202 (N.ISOL)
Z0305DG	L4004F521	S	TO-202 (N.ISOL)
Z0309BG	L2004F621	S	TO-202 (N.ISOL)
Z0309DG	L4004F621	S	TO-202 (N.ISOL)
Z0310BG	L2004F821	S	TO-202 (N.ISOL)
Z0310DG	L4004F821	S	TO-202 (N.ISOL)
Z0310MG	L6004L8	S	TO-220 (ISOL)
Z0405BE	L2004F51	D	TO-202 (N.ISOL)
Z0405BF	L2004F52	D	TO-202 (N.ISOL)
Z0405DE	L4004F51	D	TO-202 (N.ISOL)
Z0405DF	L4004F52	D	TO-202 (N.ISOL)
Z0405ME	L6004F51	D	TO-202 (N.ISOL)
Z0405MF	L6004F52	D	TO-202 (N.ISOL)
Z0409BE	L2004F61	D	TO-202 (N.ISOL)
Z0409BF	L2004F62	D	TO-202 (N.ISOL)
Z0409DE	L4004F61	D	TO-202 (N.ISOL)
Z0409DF	L4004F62	D	TO-202 (N.ISOL)
Z0409ME	L6004F61	D	TO-202 (N.ISOL)
Z0409MF	L6004F62	D	TO-202 (N.ISOL)
Z0410BE	L2004F81	D	TO-202 (N.ISOL)
Z0410BF	L2004F82	D	TO-202 (N.ISOL)
Z0410DE	L4004F81	D	TO-202 (N.ISOL)

Cross Reference Guide

Part Number	Teccor Device	Direct or Suggested Replacement	Teccor Package
Z0410DF	L4004F82	D	TO-202 (N.ISOL)
Z0410ME	L6004F81	D	TO-202 (N.ISOL)
Z0410MF	L6004F82	D	TO-202 (N.ISOL)

Application Notes

Fundamental Characteristics of Thyristors

Introduction

The thyristor family of semiconductors consists of several very useful devices. The most widely used of this family are silicon controlled rectifiers (SCRs), triacs, and diacs. There are many applications where these devices perform key functions and are real assets in meeting environmental, speed, and reliability specifications which their electro-mechanical counterparts cannot fulfill. Since they are different from their electro-mechanical counterparts in many ways, there are many characteristics, terms and parameters which must be understood. The purpose of this application note is to better acquaint users of SCRs, triacs, and diacs to the basic fundamentals of these thyristors.

Basic Operation of an SCR

Simple block construction of an SCR is shown in Figure 14.1.

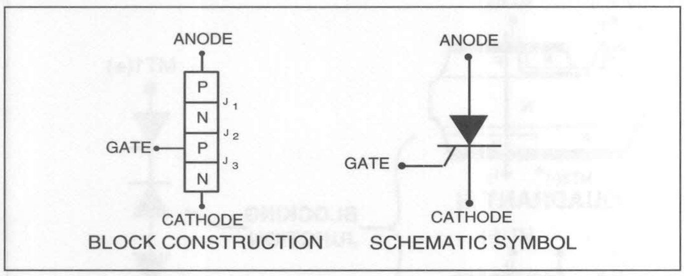


Figure 14.1 SCR Block Construction

The operation of a PNPN device can best be visualized as a specially coupled pair of transistors as shown in Figure 14.2.

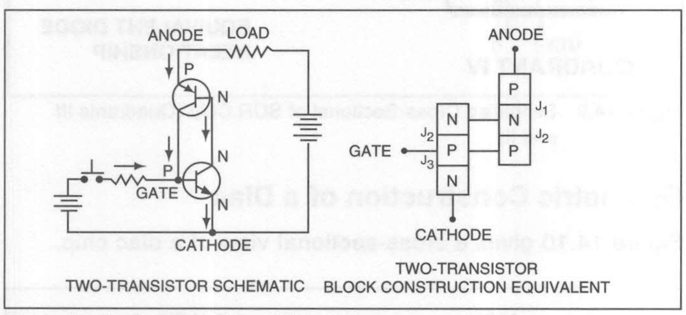


Figure 14.2 Coupled Pair of Transistors

The connections between the two transistors are such that regenerative action can occur when a proper gate signal is applied to the base of the NPN transistor. Normal leakage current is so low that the combined h_{FE} of the specially coupled two-transistor feedback amplifier is less than unity, thus keeping the circuit in an off-state condition. A momentary positive pulse applied to the gate will bias the NPN transistor into conduction which, in turn, biases the PNP transistor into conduction. The effective h_{FE} momentarily becomes greater than unity so that the specially coupled transistors saturate. Once saturated, current through the transistors is enough to keep the combined h_{FE} greater than unity. The circuit will remain "on" until it is "turned off" by reducing the anode-to-cathode current (I_T) such that the combined h_{FE} is less than unity and regeneration ceases; this threshold anode current is the holding current of the SCR.

Basic Operation of a Triac

Simple block construction of a triac is shown in Figure 14.3. Its primary function is to control power bilaterally in an AC circuit.

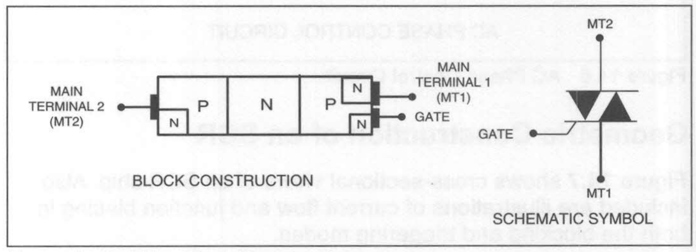


Figure 14.3 Triac Block Construction

Operation of a triac can be related to two SCRs connected in parallel in opposite directions as shown in Figure 14.4.

Although the gates are shown separately for each SCR in Figure 14.4, a triac has a single gate and can be triggered by either polarity.

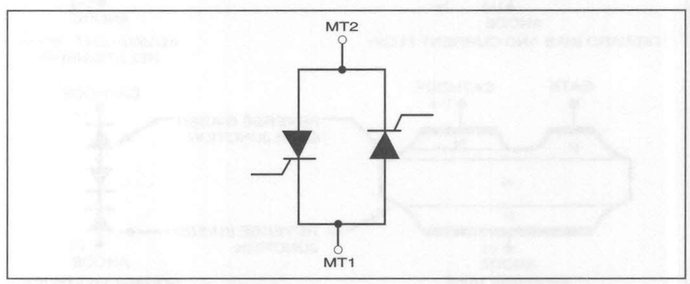


Figure 14.4 Connected SCRs

Since a triac operates in both directions, it behaves essentially the same in either direction as an SCR would behave in the forward direction (blocking or operating)

Basic Operation of a Diac

The construction of a diac is similar to an open base "NPN" transistor. A simple block diagram is shown in Figure 14.5.

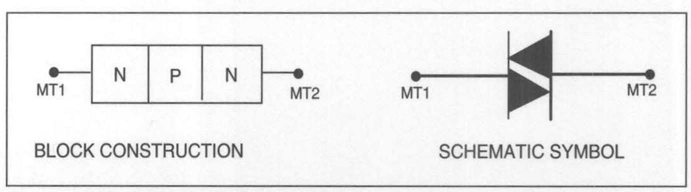


Figure 14.5 Diac Block Construction

The bidirectional transistor-like structure exhibits a high-impedance blocking state up to a voltage breakover point (V_{BO}) above which the device enters a negative-resistance region. These basic diac characteristics produce a bidirectional pulsing oscillator in a resistor-capacitor AC circuit. Since the diac is a bidirec-

tional device, it makes a good economical trigger for firing triacs in phase control circuits like light dimmers, motor speed controls, etc. Figure 14.6 is a simplified AC circuit using a diac and a triac in a phase control application.

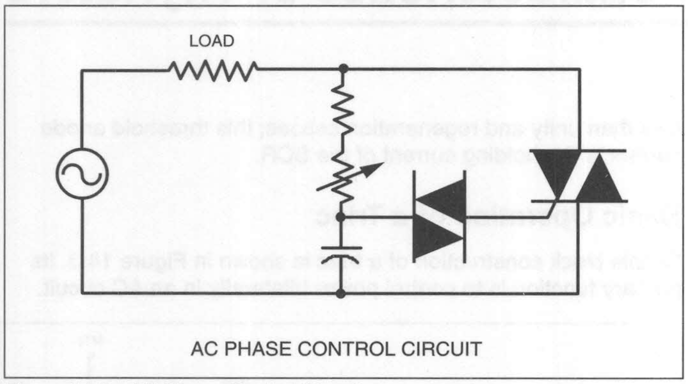


Figure 14.6 AC Phase Control Circuit

Geometric Construction of an SCR

Figure 14.7 shows cross-sectional views of an SCR chip. Also included are illustrations of current flow and junction biasing in both the blocking and triggering modes.

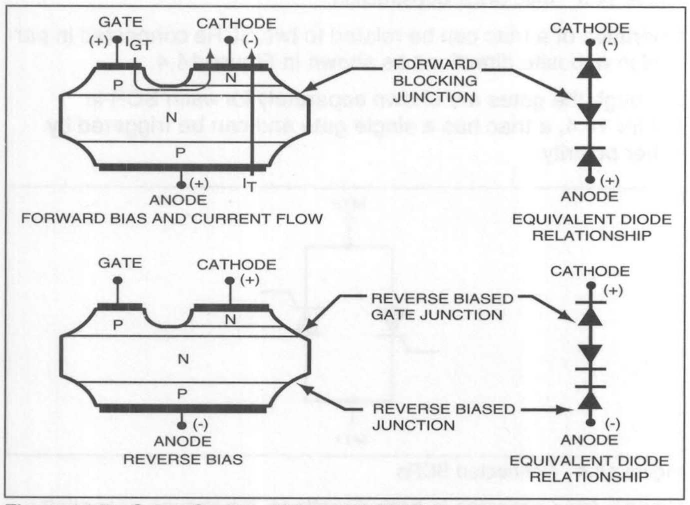


Figure 14.7 Cross-Sectional View of SCR Chip

Geometric Construction of a TRIAC

Figures 14.8 and 14.9 give simplified cross-sectional views of a triac chip. Illustrations are shown in various gating quadrants and blocking modes.

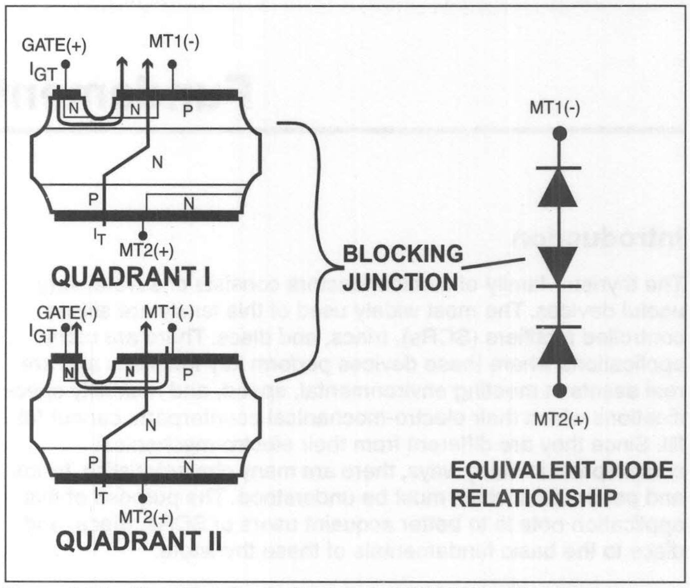


Figure 14.8 Simplified Cross-Sectional of SCR Chip (Quadrants I and II)

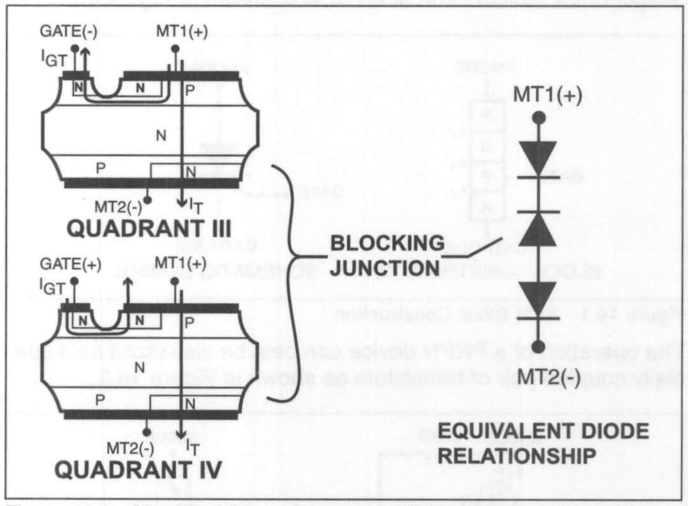


Figure 14.9 Simplified Cross-Sectional of SCR Chip (Quadrants III and II)

Geometric Construction of a Diac

Figure 14.10 gives a cross-sectional view of a diac chip.

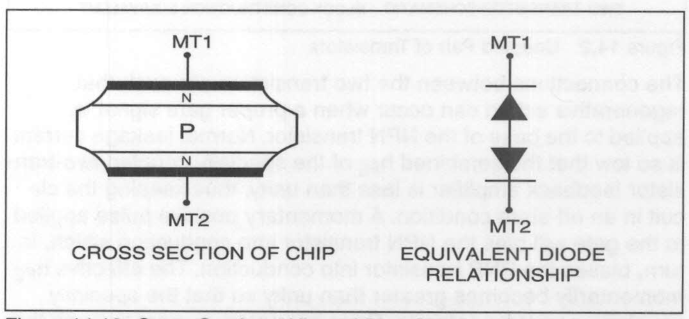


Figure 14.10 Cross-Sectional View of Diac Chip

Electrical Characteristic Curves of Thyristors

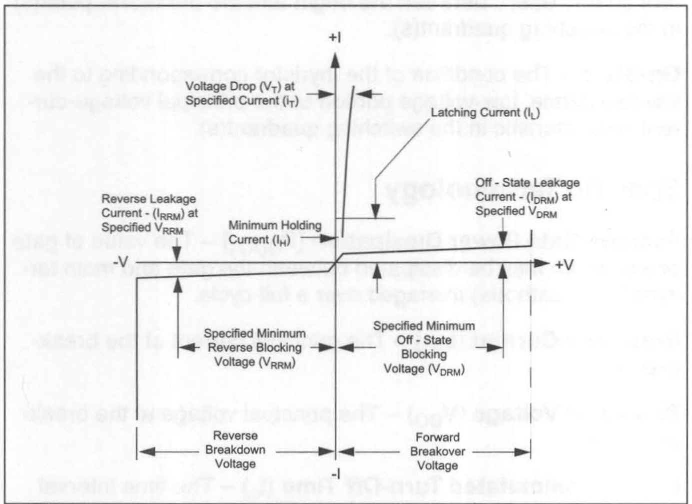


Figure 14.11 V-I Characteristics of SCR Device

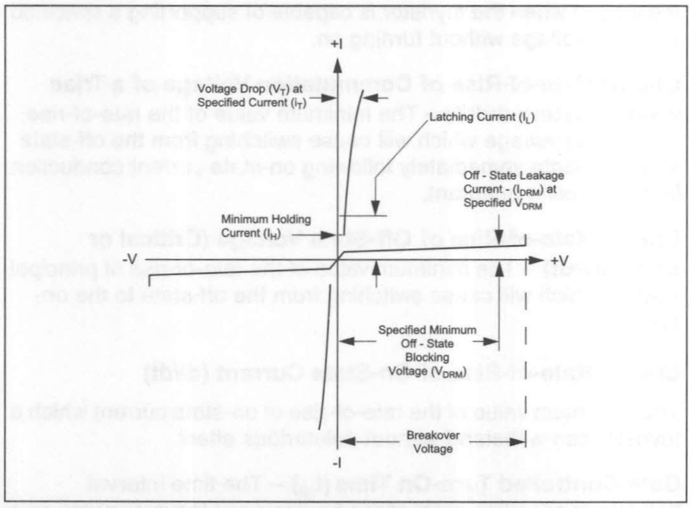


Figure 14.12 V-I Characteristics of Triac Device

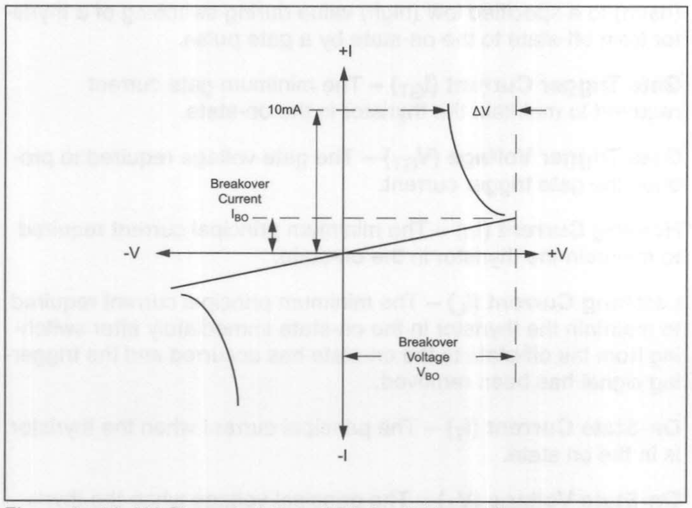


Figure 14.13 V-I Characteristics of Bilateral Trigger Diac

Methods of Switching on Thyristors

There are three general ways to switch thyristors to on-state condition:

- Application of Gate Signal
- Static dv/dt Turn-On
- Voltage Breakover Turn-On

Listed below is a brief description of each method.

Application Of Gate Signal

Must exceed I_{GT} and V_{GT} requirements of thyristor being used. For an SCR (unilateral device), this signal must be positive with respect to the cathode polarity. A triac (bilateral device) can be turned on with gate signal of either polarity; however, different polarities have different requirements of I_{GT} and V_{GT} which must be satisfied. Since a diac does not have a gate, this method of turn-on is not applicable to diacs; in fact, the single major application of diacs is to switch-on triacs.

Static dv/dt Turn-On

Comes from a fast rising voltage applied across the anode and cathode terminals of an SCR or the main terminals of a triac. Due to the nature of thyristor construction, a small junction capacitor is formed across each PN junction. Figure 14.14 shows how typical internal capacitors are linked in gated thyristors. When voltage is impressed suddenly across a PN junction, a charging current will flow which is equal to:

$$i = C\left(\frac{dv}{dt}\right)$$

When $C\left(\frac{dv}{dt}\right)$ becomes greater or equal to thyristor I_{GT}, the thyristor switches on. Normally, this type of turn on does not damage or hurt the device providing the surge current is limited.

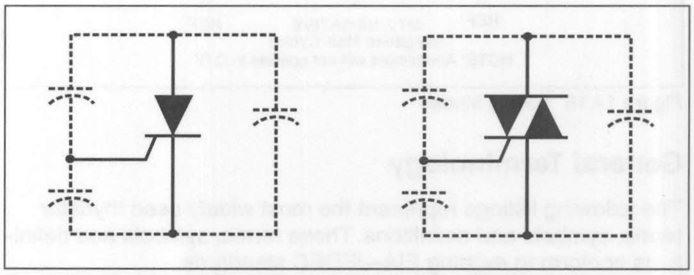


Figure 14.14 Internal Capacitors Linked in Gated Thyristors

Generally, thyristor application circuits are designed with static dv/dt snubber networks if fast rising voltages are anticipated.

Voltage Breakover Turn-On

Is the method used to switch on diacs. However, exceeding voltage breakover of SCRs and triacs is definitely not recommended as a turn-on method.

In the case of SCRs and triacs, the leakage current increases until it exceeds the gate current required to turn-on these gated thyristors in a small localized point. When turn-on occurs by this method, there is localized heating in a small area which may melt the silicon or damage the device if di/dt of the increasing current is not sufficiently limited.

Diacs used in typical phase control circuits are basically protected against excessive current at breakover as long as the fir-

ing capacitor is not excessively large. When diacs are used in a zener function, current limiting is necessary.

Triac Gating Modes Of Operation

Triacs can be gated in four basic gating modes as shown in Figure 14.15.

The most common quadrants for triac gating-on are Quadrants I and III, where the gate supply is synchronized (gate positive, MT2 positive; or gate negative, MT2 negative) with the main terminal supply. Gate sensitivity of triacs is most optimum in Quadrants I and III due to the inherent thyristor chip construction. If, however, Quadrants I and III operation cannot be used, the next best operating modes are Quadrants II and III where the gate has a negative polarity supply with an AC main terminal supply. Typically, Quadrant II is approximately equal in gate sensitivity to Quadrant I; however, latching current sensitivity in Quadrant II is lowest. Therefore, it is difficult for triacs to latch on in quadrant II when the main terminal current supply is very low in value.

Quadrant IV has the lowest gate sensitivity of all four operating quadrants. Considerations should be given in gating circuit design when Quadrants I and IV are used in actual application.

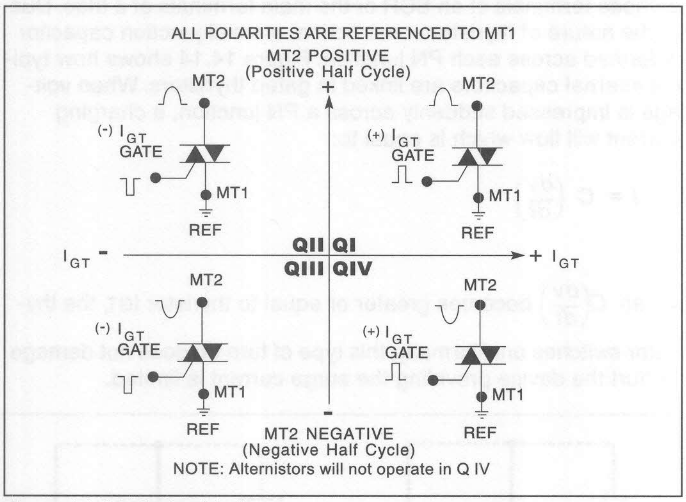


Figure 14.15 Gating Modes

General Terminology

The following listings represent the most widely used thyristor terms, symbols and definitions. These terms, symbols and definitions conform to existing EIA–JEDEC standards.

Breakover Point – Any point on the principal voltage-current characteristic for which the differential resistance is zero and where the principal voltage reaches a maximum value.

Principal Current – A generic term for the current through the collector junction. Note: It is the current through main terminal 1 and main terminal 2 of a triac or anode and cathode of an SCR.

Principal Voltage – The voltage between the main terminals.

(1) In the case of reverse blocking thyristors, the principal voltage is called positive when the anode potential is higher than the cathode potential, and called negative when the anode potential is lower than the cathode potential.

(2) For bidirectional thyristors, the principal voltage is called positive when the potential of main terminal 2 is higher than the potential of main terminal 1.

Off-State – The condition of the thyristor corresponding to the high-resistance, low-current portion of the principal voltage-current characteristic between the origin and the breakover point(s) in the switching quadrant(s).

On-State – The condition of the thyristor corresponding to the low-resistance, low-voltage portion of the principal voltage-current characteristic in the switching quadrant(s).

Specific Terminology

Average Gate Power Dissipation [$P_{G(AV)}$] – The value of gate power which may be dissipated between the gate and main terminal 1 (or cathode) averaged over a full cycle.

Breakover Current (I_{BO}) – The principal current at the breakover point.

Breakover Voltage (V_{BO}) – The principal voltage at the breakover point.

Circuit-Commutated Turn-Off Time (t_q) – The time interval between the instant when the principal current has decreased to zero after external switching of the principal voltage circuit, and the instant when the thyristor is capable of supporting a specified principal voltage without turning on.

Critical Rate-of-Rise of Commutation Voltage of a Triac (Commutating dv/dt) – The minimum value of the rate-of-rise of principal voltage which will cause switching from the off-state to the on-state immediately following on-state current conduction in the opposite quadrant.

Critical Rate-of-Rise of Off-State Voltage (Critical or Static dv/dt) – The minimum value of the rate-of-rise of principal voltage which will cause switching from the off-state to the on-state.

Critical Rate-of-Rise of On-State Current (di/dt)

The maximum value of the rate-of-rise of on-state current which a thyristor can withstand without deleterious effect.

Gate-Controlled Turn-On Time (t_{gt}) – The time interval between a specified point at the beginning of the gate pulse and the instant when the principal voltage (current) has dropped (risen) to a specified low (high) value during switching of a thyristor from off-state to the on-state by a gate pulse.

Gate Trigger Current (I_{GT}) – The minimum gate current required to maintain the thyristor in the on-state.

Gate Trigger Voltage (V_{GT}) – The gate voltage required to produce the gate trigger current.

Holding Current (I_H) – The minimum principal current required to maintain the thyristor in the on-state.

Latching Current (I_L) – The minimum principal current required to maintain the thyristor in the on-state immediately after switching from the off-state to the on-state has occurred and the triggering signal has been removed.

On-State Current (I_T) – The principal current when the thyristor is in the on state.

On-State Voltage (V_T) – The principal voltage when the thyristor is in the on-state.

Specific Terminology (continued)

Peak Gate Power Dissipation (P_{GM}) – The maximum power which may be dissipated between the gate and main terminal 1 (or cathode) for a specified time duration.

Repetitive Peak Off-State Current (I_{DRM}) – The maximum instantaneous value of the off-state current that results from the application of repetitive peak off-state voltage.

Repetitive Peak Off-State Voltage (V_{DRM}) – The maximum instantaneous value of the off-state voltage which occurs across a thyristor, including all repetitive transient voltages, but excluding all non-repetitive transient voltages.

Repetitive Peak Reverse Current of an SCR (I_{RRM}) – The maximum instantaneous value of the reverse current that results from the application of repetitive peak reverse voltage.

Repetitive Peak Reverse Voltage of an SCR (V_{RRM}) – The maximum instantaneous value of the reverse voltage which occurs across the thyristor, including all repetitive transient voltages, but excluding all non-repetitive transient voltages.

Surge (Non-Repetitive) On-State Current (I_{TSM}) – An on-state current of short-time duration and specified waveshape.

Thermal Resistance, Junction to Ambient ($R_{\theta JA}$) – The temperature difference between the thyristor junction and ambient divided by the power dissipation causing the temperature difference under conditions of thermal equilibrium.
Note: Ambient is defined as the point where temperature does not change as the result of dissipation.

Thermal Resistance, Junction to Case ($R_{\theta JC}$) – The temperature difference between the thyristor junction and the thyristor case divided by the power dissipation causing the temperature difference under conditions of thermal equilibrium.

Notes

Gating, Latching, and Holding of SCRs and Triacs

Introduction

Gating, latching, and holding currents of thyristors are some of the most important parameters. These parameters and their interrelationship determine whether the SCRs and triacs will function properly in various circuit applications. The purpose of this application note is to show the users of SCRs and triacs how these parameters are related to each other and help the users in selecting best operating modes for various circuit applications.

Gating of SCRs and Triacs

There are three general ways to switch thyristors to on-state condition:

(1) Applying proper gate signal

(2) Exceeding thyristor static dv/dt characteristics

(3) Exceeding voltage breakover point

For the purposes of this application note, only the "Application of proper gate signal" will be examined. Gate signal must exceed the I_{GT} and V_{GT} requirements of thyristor being used. I_{GT} (gate trigger current) is defined as minimum gate current required to switch a thyristor from the off-state to the on-state. V_{GT} (gate trigger voltage) is defined as the voltage required to produce the gate trigger current.

SCRs (unilateral device) require a positive gate signal with respect to the cathode polarity. Figure 15.1 shows the current flow in a cross-sectional view of the SCR chip.

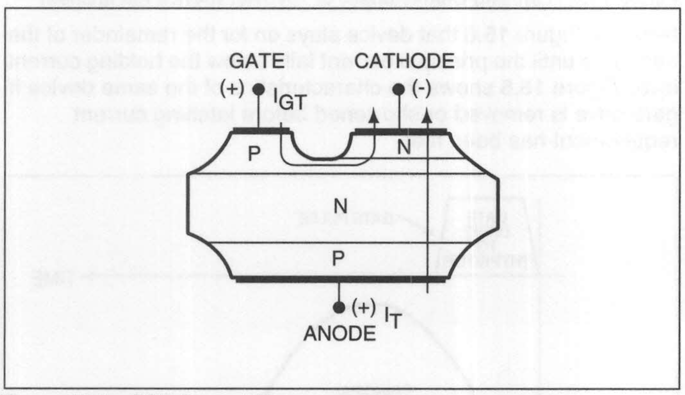


Figure 15.1 SCR Current Flow

In order for the SCR to latch on, the anode-to-cathode current (I_T) must exceed the latching current (I_L) requirement. Once it is latched on, the SCR will remain "on" until it is "turned off" when anode-to-cathode current drops below holding current (I_H) requirement.

Triacs (bilateral device) can be gated on with a gate signal of either polarity with respect to the MT1 terminal; however, different polarities have different requirements of I_{GT} and V_{GT}. Figure 15.2 illustrates current flow through the triac chip in various gating modes.

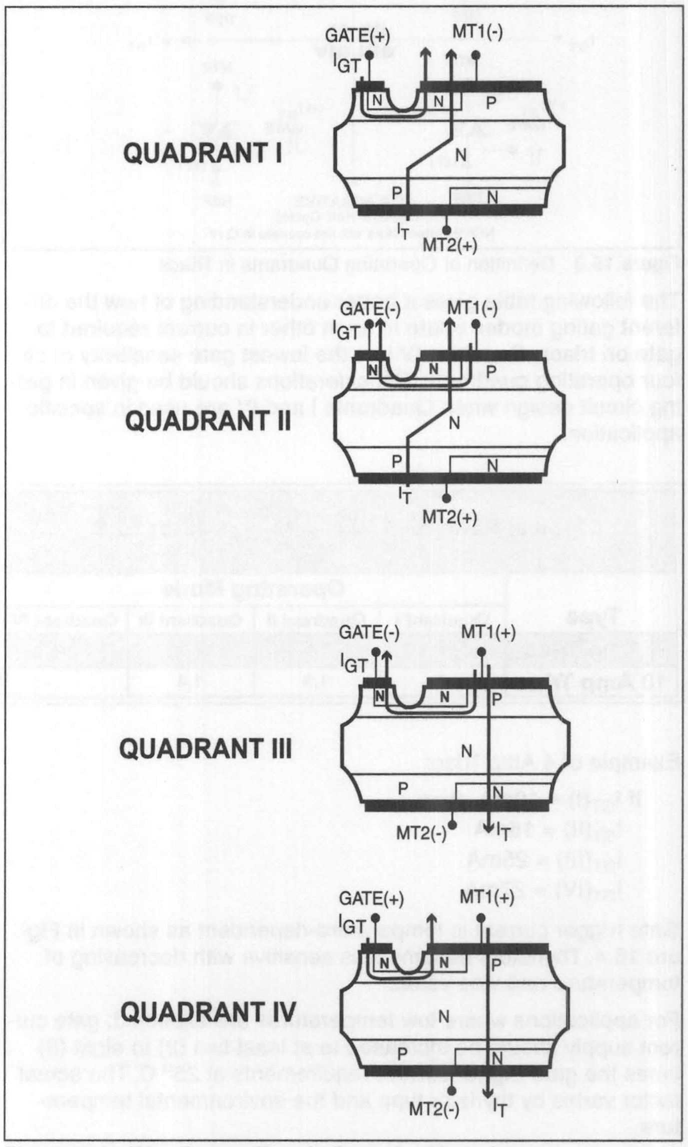


Figure 15.2 Triac Current Flow (4 Operating Modes)

Triacs can be gated on in four (4) basic gating modes as shown in Figure 15.3. The most common Quadrants for gating on triacs are Quadrants I and III, where the gate supply is synchronized with the main terminal supply; i.e., gate positive — MT2 positive, gate negative — MT2 negative. Optimum triac gate sensitivity is achieved when operating in Quadrants I and III due to the inherent thyristor chip construction. If, however, Quadrants I and III operation cannot be used, the next best operating modes are Quadrants II and III, where the gate supply is negative with respect to AC main terminal supply. Typically, the gate sensitivities of Quadrants I and II are approximately equal; however, quadrant II has the lowest latching current sensitivity. Therefore,

it is difficult for triacs to latch on in Quadrant II when the main terminal current supply is very low in value.

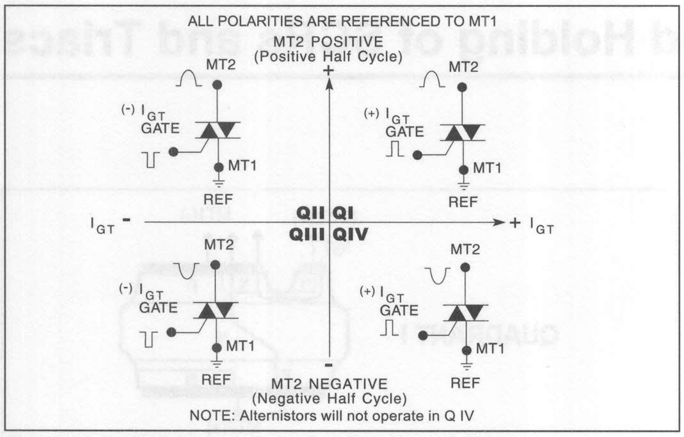


Figure 15.3 Definition of Operating Quadrants in Triacs

The following table gives a better understanding of how the different gating modes relate to each other in current required to gate on triacs. Quadrant IV has the lowest gate sensitivity of all four operating quadrants. Considerations should be given in gating circuit design when Quadrants I and IV are used in specific application.

Typical Ratio of $\frac{I_{GT}(\text{In given Quadrant})}{I_{GT}(\text{Quadrant})}$ at 25˚C

Type	Operating Mode			
	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
4 Amp Triac	1	1.6	2.5	2.7
10 Amp Triac	1	1.5	1.4	

Example of 4 Amp Triac:

If I_{GT}(I) = 10mA, then
I_{GT}(II) = 16mA
I_{GT}(III) = 25mA
I_{GT}(IV) = 27mA

Gate trigger current is temperature-dependent as shown in Figure 15.4. Thyristors become less sensitive with decreasing of temperature and vice versa.

For applications where low temperatures are expected, gate current supply should be increased to at least two (2) to eight (8) times the gate trigger current requirements at 25^{o} C. The actual factor varies by thyristor type and the environmental temperature.

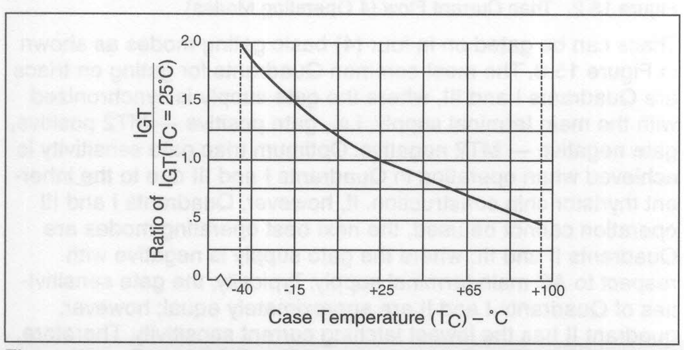


Figure 15.4 Typical DC Gate Trigger Current vs Case Temperature

Example of 10 Amp Triac:

If $I_{GT(I)}$ = 10mA at 25˚C, then
$I_{GT(I)}$ = 20mA at -40˚C

In applications where high di/dt, high surge, and fast turn on are expected, gate drive current should be steep rising (1µs rise time) and at least twice rated I_{GT} or higher with minimum 3 µs pulse duration. However, if gate drive current magnitude is very high, then duration may have to be limited to keep from overstressing (exceeding the power dissipation limit of) gate junction.

Latching Current of SCRs and TRIACS

Latching current (I_L) is defined as the minimum principal current required to maintain the thyristor in the on-state immediately after the switching from the off-state to the on-state has occurred, and the triggering signal has been removed. Latching current can best be understood by relating to the "pick-up" or "pull-in" level of a mechanical relay. Figures 15.5 and 15.6 illustrate typical thyristor latching phenomenon.

In Figure 15.5, the thyristor does not stay on after gate drive is removed due to insufficient available principal current (which is lower than the latching current requirement).

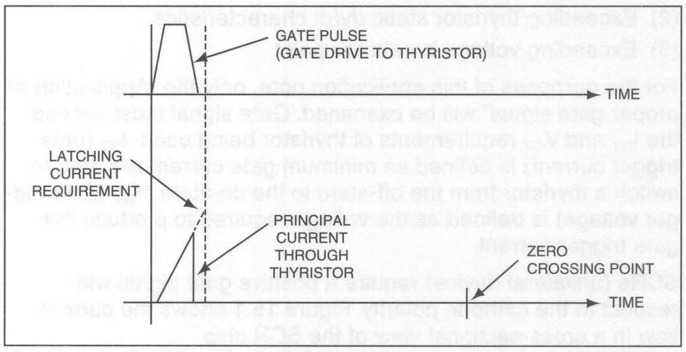


Figure 15.5 Latching Characteristic of Thyristor (device not latched)

Notice in Figure 15.6 that device stays on for the remainder of the half cycle until the principal current falls below the holding current level. Figure 15.5 shows the characteristics of the same device if gate drive is removed or shortened before latching current requirement has been met.

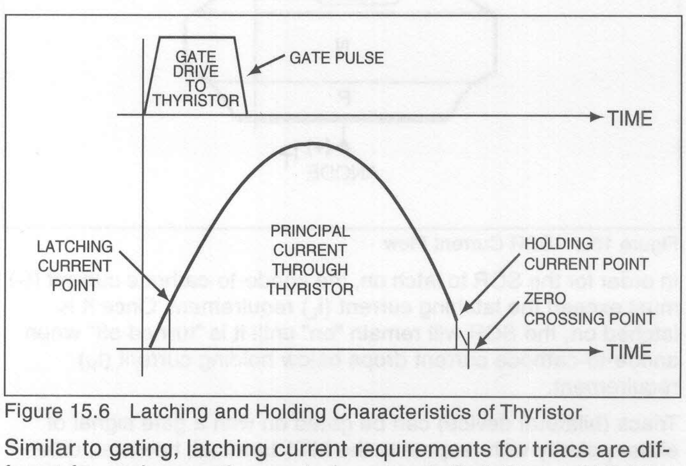


Figure 15.6 Latching and Holding Characteristics of Thyristor

Similar to gating, latching current requirements for triacs are different for each operating mode (quadrant). Definitions of latching modes (quadrants) are the same as gating modes; hence, Figures 15.2 and 15.3 can be used to describe latching modes (quadrants) as well. The following table shows how different latching modes (quadrants) relate to each other. As previously

stated, Quadrant II has lowest latching current sensitivity of all four operating quadrants.

Typical Ratio of $\frac{I_L(\text{In given Quadrant})}{I_L(\text{Quadrant I})}$ at 25˚C				
Type	Operating Mode			
	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
4 Amp Triac	1	4	1.2	1.1
10 Amp Triac	1	4	1.1	1

Example of 4 Amp Triac:

If $I_L(I) = 10mA$, then
$I_L(II) = 40mA$
$I_L(III) = 12mA$
$I_L(IV) = 11mA$

Latching current has even somewhat greater temperature dependence compared to the DC gate trigger current. Application with low temperature requirements should have sufficient principal current (anode current) available to insure thyristor latch on.

Two key test conditions on latching current specifications are gate drive and available principal (anode) current durations. Shortening the gate drive duration can result in higher latching current values.

Holding Current of SCRs and Triacs

Holding current (IH) is defined as the minimum principal current required to maintain the thyristor in the on-state. Holding current can best be understood by relating it to the "drop-out" or "must release" level of a mechanical relay. Figure 15.6 shows the sequences of gate, latching, and holding currents. Holding current will always be less than latching. However, the more sensitive the device, the closer the holding current value approaches its latching current value.

Holding current is independent of gating and latching, but the device must be fully latched on before a holding current limit can be determined.

Holding current modes of the thyristor are strictly related to the voltage polarity across the main terminals. The following table illustrates how the positive and negative holding current modes of triacs relate to each other.

Typical Triac Holding Current Ratio		
Type	Operating Mode	
	$I_H(+)$	$I_H(-)$
4 Amp Triac	1	1.1
10 Amp Triac	1	1.3

Example of 10 Amp Triac:

If $I_H(+) = 10mA$, then
$I_H(-) = 13mA$

Holding current is also temperature dependent like gating and latching as shown in Figure 15.7. Notice that the initial on-state current is 200 mA to ensure that the thyristor is fully latched on prior to holding current measurement. Again, applications with low temperature requirements should have sufficient principal (anode) current available to maintain the thyristor in the on-state condition.

Both minimum and maximum holding current specifications may be important, depending on application. Maximum holding current must be considered if the thyristor is to stay in conduction at low principal (anode) current; whereas, the minimum holding current must be considered if the device is expected to turn off at a low principal (anode) current.

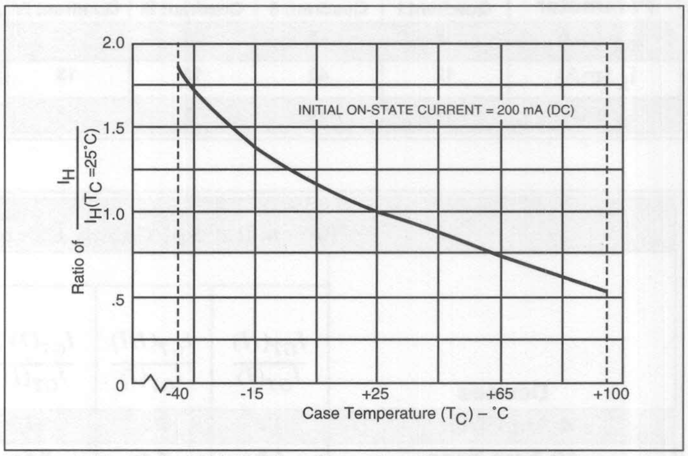


Figure 15.7 Typical DC Holding Current vs Case Temperatures

Example of 10 Amp Triac:

If $I_H(+) = 10mA$ at 25˚C, then
$I_H(+) \approx 7.5mA$ at 65˚C

Relationship of Gating, Latching, and Holding Currents

Although gating, latching, and holding currents are independent of each other in some ways, the parameter values are related. If gating is very sensitive, latching and holding will also be very sensitive and vice versa. One way to obtain a sensitive gate and not-so-sensitive latching-holding characteristics is to have an "amplified gate" as shown in Figure 15.8.

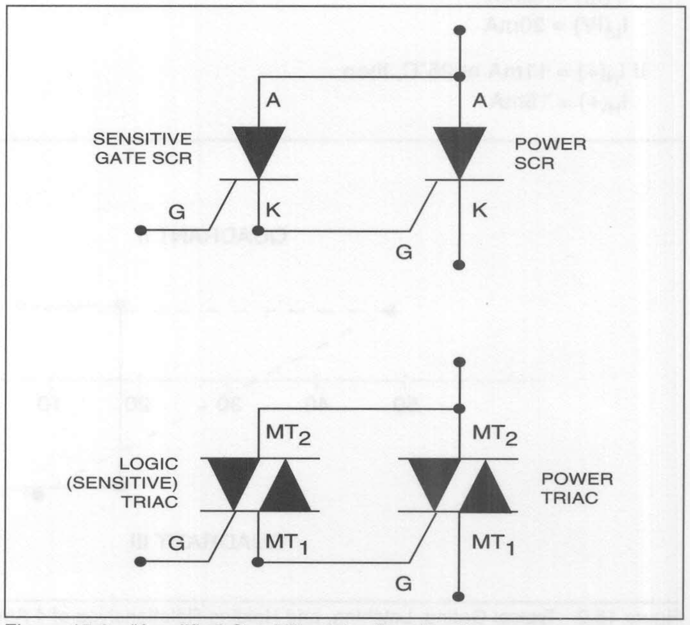


Figure 15.8 "Amplified Gate" Thyristor Construction

The following table and Figure 15.9 show the relationship of gating, latching, and holding of a 4 Amp device in table and graphic forms.

Typical 4 Amp Triac Gating, Latching, and Holding Relationship				
	Quadrants or Operating Mode			
Parameter	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
I_{GT} (mA)	10	16	25	27
I_L (mA)	12	48	15	13
I_H (mA)	10	10	11	11

The relationships of gating, latching, and holding for several device types are shown in the following table. All the ratios are referenced to Quadrant I gating for convenience.

Typical Ratio of Gating, Latching, and Holding Currents at 25˚C									
	Ratio								
Devices	$\frac{I_{GT}(II)}{I_{GT}(I)}$	$\frac{I_{GT}(III)}{I_{GT}(I)}$	$\frac{I_{GT}(IV)}{I_{GT}(I)}$	$\frac{I_L(I)}{I_{GT}(I)}$	$\frac{I_L(II)}{I_{GT}(I)}$	$\frac{I_L(III)}{I_{GT}(I)}$	$\frac{I_L(IV)}{I_{GT}(I)}$	$\frac{I_H(+)}{I_{GT}(I)}$	$\frac{I_H(-)}{I_{GT}(I)}$
4 Amp Triac	1.6	2.5	2.7	2.7	.9.5	3.0	2.0	2.5	2.6
10 Amp Triac	1.5	1.4	8.5	1.6	4.0	1.8	2.0	1.1	1.6
15 Amp Alternistor	1.5	1.8	–	2.4	7.0	2.1	–	2.2	1.9
1 Amp Sensitive SCR	–	–	–	25	–	–	–	25	–
6 Amp SCR	–	–	–	3.2	–	–	–	2.6	–

Examples of 10 Amp Triac:

If I_{GT}(I) = 10mA, then
I_{GT}(II) = 15mA
I_{GT}(III) = 14mA
I_{GT}(IV) = 85mA

If I_L(I) = 16mA, then
I_L(II) = 40mA
I_L(III) = 18mA
I_L(IV) = 20mA

If I_H(+) = 11mA at 25˚C, then
I_H(+) = 16mA

Summary

Gating, latching and holding currents characteristics of thyristors are quite important yet predictable (once a single parameter value is known). Their interrelationships (ratios) can also be used to help designers in both initial circuit application design as well as device selection.

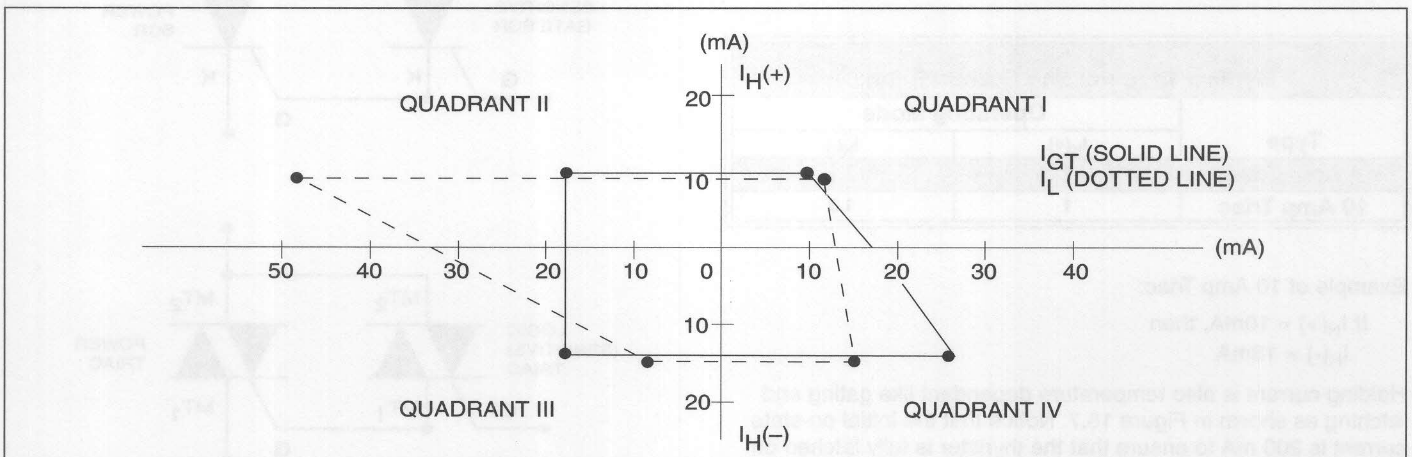


Figure 15.9 Typical Gating, Latching, and Holding Relationships of 4 Amp Triac at 25˚C

Phase Control Using Thyristors

Introduction

Due to high volume production techniques, thyristors are now priced so that almost any electrical product can benefit from electronic control. By looking at the fundamentals of SCR and triac phase controls, one can see how this is possible.

Output Power Characteristics

Phase control is the most common form of thyristor power control. The thyristor is held in the "off" condition (all current flow in the circuit is blocked by the thyristor except a minute leakage current). The thyristor is then triggered into an "on" condition by the control circuitry.

For full-wave AC control, a single triac or two SCRs connected in inverse parallel may be used. Two methods may be used for full-wave DC control; either a bridge rectifier formed by two SCRs or an SCR placed in series with a diode bridge as shown in Figure 16.1.

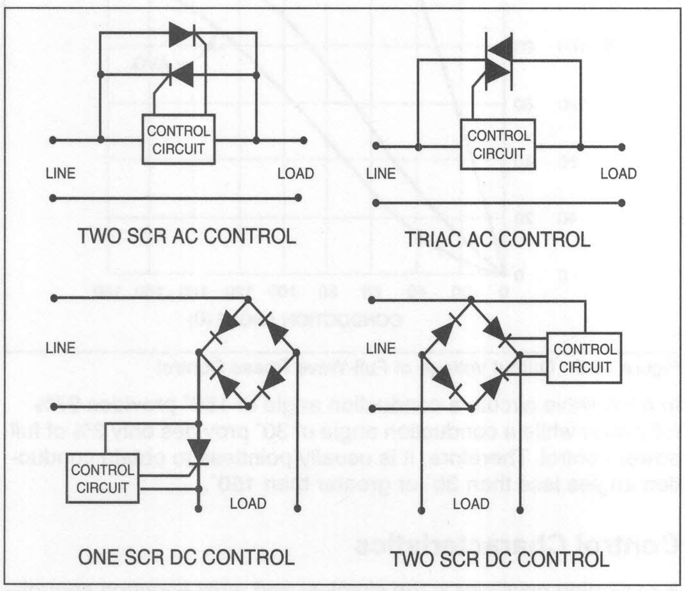


Figure 16.1 SCR/Triac Connections for Various Methods of Phase Control

Voltage waveform and some common terms used to describe thyristor operation are illustrated in Figure 16.2. Delay angle is the time during which the thyristor blocks the line voltage. The conduction angle is the time during which the thyristor is on.

It is important to note that the circuit current is determined by the load and power source. For simplification purposes, assume the load is resistive; hence, both the voltage and current waveforms are identical.

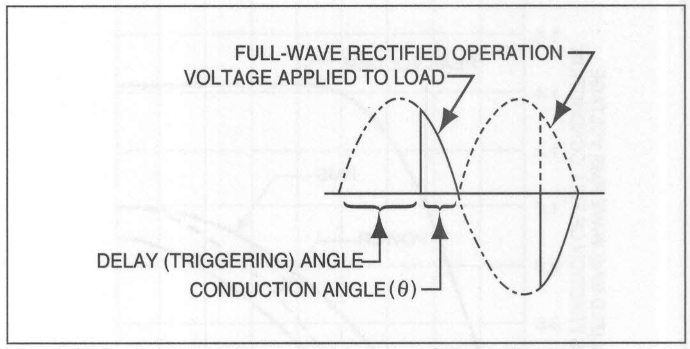


Figure 16.2 Sine Wave Showing Principles of Phase Control

Different loads respond to different characteristics of the AC waveform. For example, some are sensitive to average voltage, some to RMS voltage, and others to peak voltage. Various voltage characteristics are plotted against conduction angle for half- and full-wave phase control circuits in Figures 16.3 and 16.4.

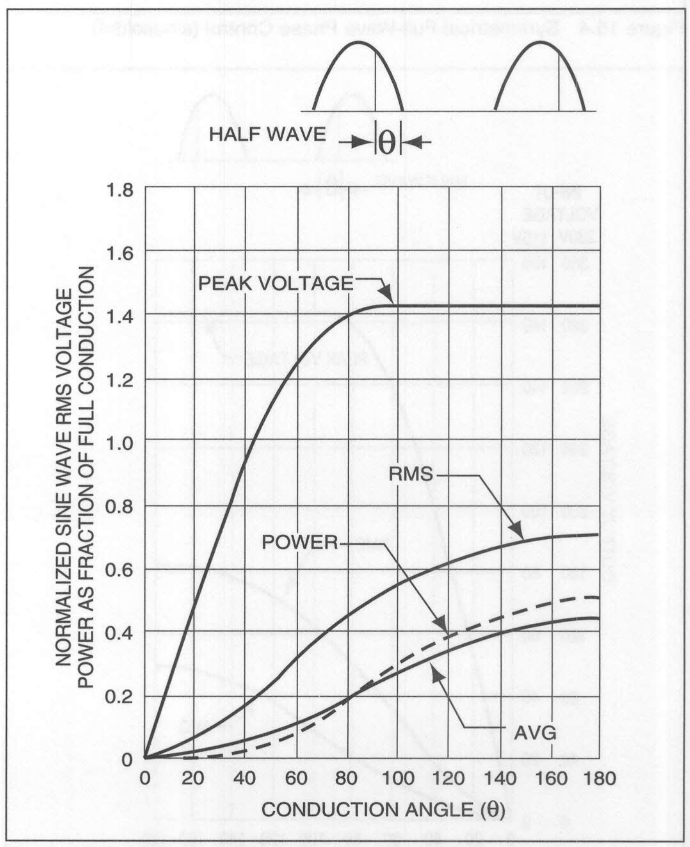


Figure 16.3 Half-Wave Phase Control (sinusoidal)

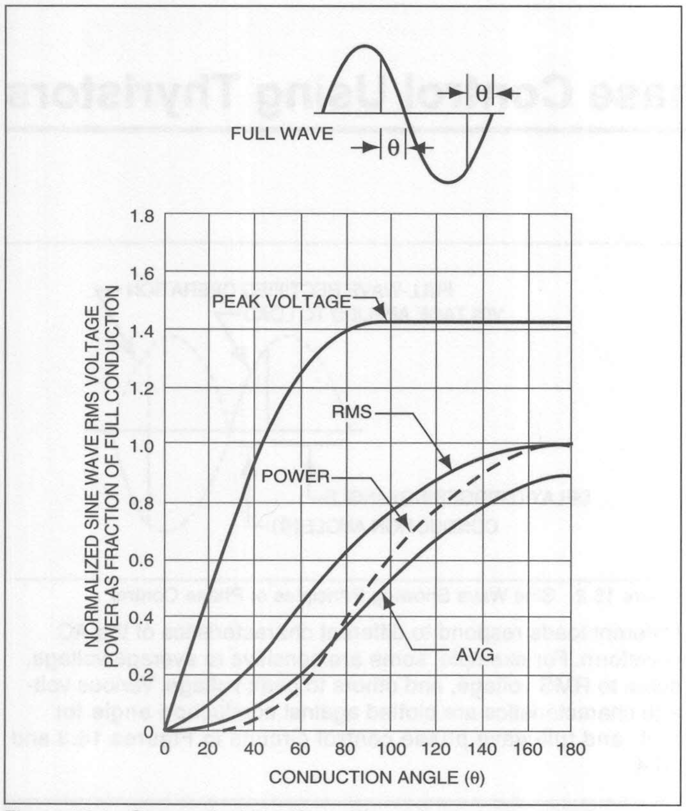


Figure 16.4 Symmetrical Full-Wave Phase Control (sinusoidal)

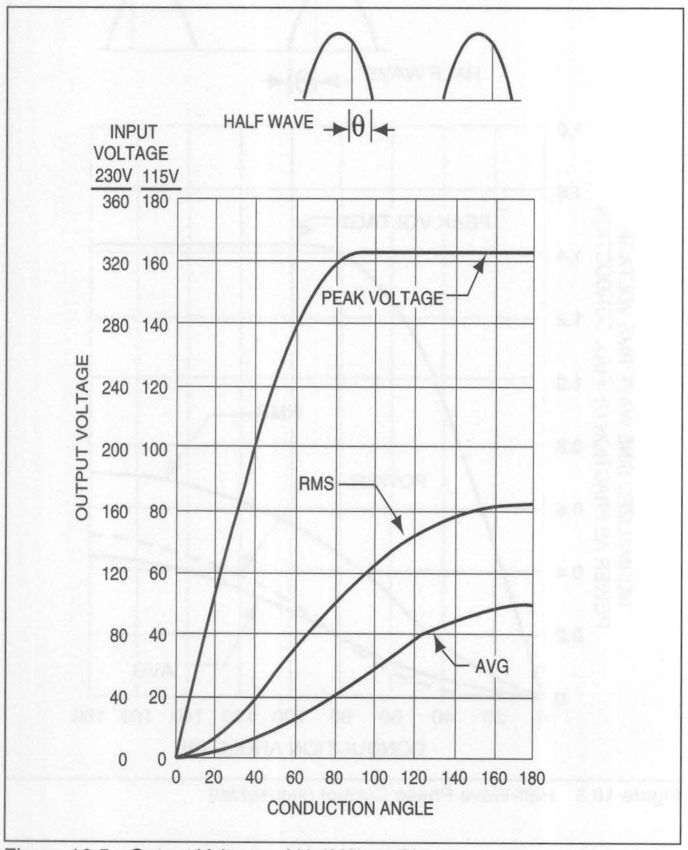


Figure 16.5 Output Voltage of Half-Wave Phase

Figures 16.5 and 16.6 give convenient direct output voltage readings for 115V/230V input voltage. These curves also apply to current in a resistive circuit.

Figures 16.3 and 16.4 show the relative power curve for constant impedance loads such as heaters. The relative impedance of incandescent lamps and motors changes with applied voltage, so they do not follow this curve precisely. To use the curves, find the full-wave rated power of the load, then multiply by the ratio associated with the specific phase angle. Thus, a 180˚ conduction angle in a half-wave circuit provides 0.5 x full-wave conduction power.

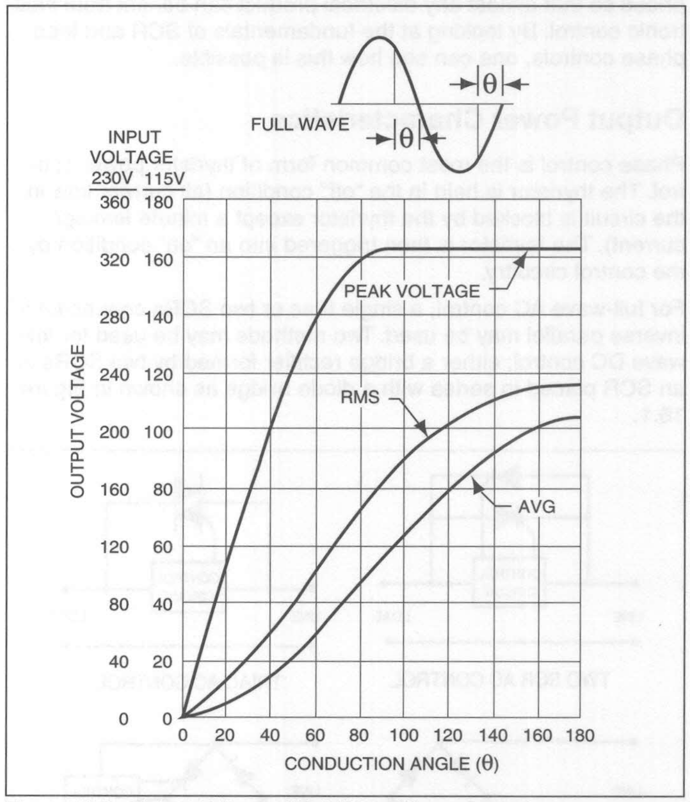


Figure 16.6 Output Voltage of Full-Wave Phase Control

In a full-wave circuit, a conduction angle of 150˚ provides 97% full power while a conduction angle of 30˚ provides only 3% of full power control. Therefore, it is usually pointless to obtain conduction angles less than 30˚ or greater than 150˚.

Control Characteristics

A relaxation oscillator is the simplest and most common control circuit for phase control. Figure 16.7 illustrates this circuit as it would be used with a thyristor. The capacitor is charged through the resistor from a voltage or current source until the breakover voltage of the switching device is reached, then the switching device changes to its “on” state, and the capacitor is discharged through the thyristor gate, thus, turn-on of the thyristor is accomplished. Trigger devices used are neon bulbs, unijunction transistors, and three-, four-, or five-layer semiconductor trigger devices. By varying the RC time constant of the charging circuit so the trigger device breakdown occurs at different phase angles within the controlled half or full cycle, phase control of the output waveform is obtained.

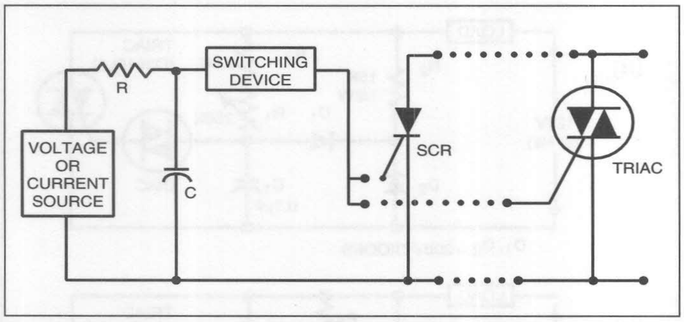


Figure 16.7 Relaxation Oscillator Thyristor Trigger Circuit

Figure 16.8 shows the capacitor voltage-time characteristic if the relaxation oscillator is to be operated from a pure DC source.

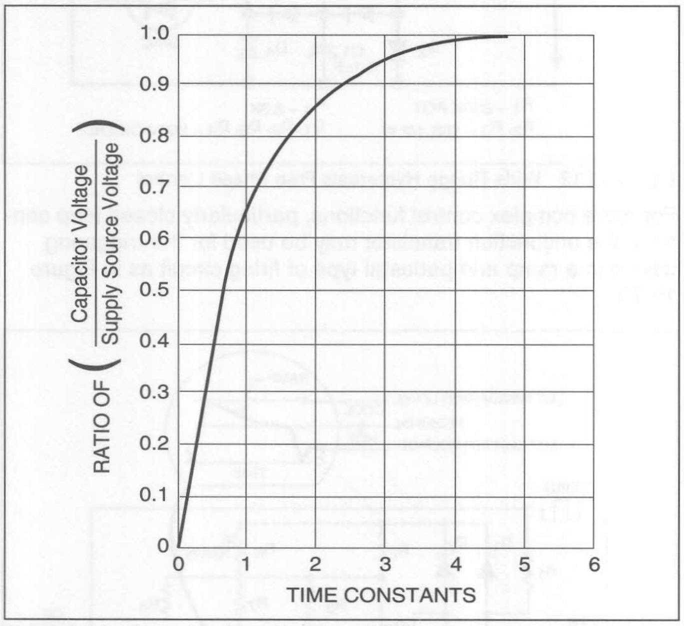


Figure 16.8 Capacitor Charging from DC Source

Usually, the design starting point is the selection of a capacitance value which will reliably trigger the thyristor when the capacitance is discharged. Trigger devices and thyristor gate triggering characteristics play a part in the selection. All the device characteristics are not always completely specified in applications, so experimental determination is sometimes needed.

When final selection of the capacitor is made, Figure 16.8 may be used in determining the charging resistance needed to obtain the desired control characteristics.

Many circuits begin each half-cycle with the capacitor voltage at or near zero. However, most circuits leave a relatively large residual voltage on the capacitor after discharge. Therefore, the charging resistor must be determined on the basis of additional charge necessary to raise the capacitor to trigger potential.

This procedure is best demonstrated with an example. Assume that we want to trigger an S2010L SCR with a 32 volt trigger diac. A 0.1µF capacitor will supply the necessary SCR gate current with the trigger diac. Assume a 50 volt DC power supply, 30˚ minimum conduction angle and 150˚ maximum conduction angle with a 60 Hz input power source. At approximately 32 volts, the diac triggers and leaves 10 volts

on the capacitor after firing. In order to trigger, 22 volts must be added to the capacitor potential, and 40 volts additional (50-10) are available. The capacitor must be charged to 22/40 or 0.55 of the available charging voltage in the desired time. From Figure 16.8, 0.55 of charging voltage represents 0.8 time constant. The 30˚ conduction angle required the firing pulse be delayed 150˚ or 6.92 milliseconds. (8.33 milliseconds is the period of 1/2 cycle at 60 Hz.) To obtain this time delay,

6.92 ms = 0.8 RC
RC = 8.68 ms

if C = 0.10µF

then, $R = \dfrac{8.68 \times 10^{-3}}{0.1 \times 10^{-6}} = 86{,}800$ Ohms

To obtain the minimum R (150˚ conduction angle), the delay is 30˚ or,

(30/180) x 8.33 = 1.39 ms
1.39 ms = 0.8 RC
RC = 1.74 ms
$R = \dfrac{1.74 \times 10^{-3}}{0.10 \times 10^{-6}} = 17{,}400$ Ohms

Using practical values, a 100K Ohm potentiometer with up to 17K minimum (residual) resistance should be used. Similar calculations using conduction angles between the maximum and minimum values will give control resistance versus power characteristic of this circuit.

Triac Phase Control

The basic full-wave triac phase control circuit shown in Figure 16.9 requires only four components. Adjustable resistor R_1 and C_1 are a single-element phase-shift network. When the voltage across C_1 reaches breakover voltage, V_{BO}, of the diac, C_1 is partially discharged by the diac into the triac gate. The triac is then triggered into the conduction mode for the remainder of that half-cycle. In this circuit, triggering is in Quadrants I and III. The unique simplicity of this circuit makes it suitable for many applications with small control range.

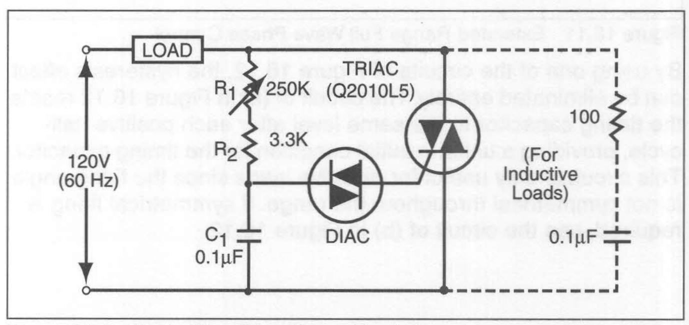


Figure 16.9 Basic Diac-Triac Phase Control

The hysteresis, or "snap back," effect is somewhat similar to the action of a kerosene lantern. That is, when the control

knob is first rotated from the off condition, the lamp can be "lit" only at some intermediate level of brightness, similar to turning up the wick to light the lantern. Brightness can then be turned down until it finally reaches the extinguishing point. If this occurs, the lamp can only be "relit" by turning up the control knob again to the intermediate level. The hysteresis effect in capacitor-diac triggering is illustrated in Figure 16.10. As R_1 is brought down from its maximum resistance, the voltage across the capacitor increases until the diac first fires at point A, at the end of a half-cycle (conduction angle qi). After the gate pulse, however, the

capacitor voltage drops suddenly to about half the triggering voltage, giving the capacitor a different initial condition. The capacitor charges to the diac triggering voltage at point B in the next half-cycle, giving a steady state conduction angle shown as q for the triac.

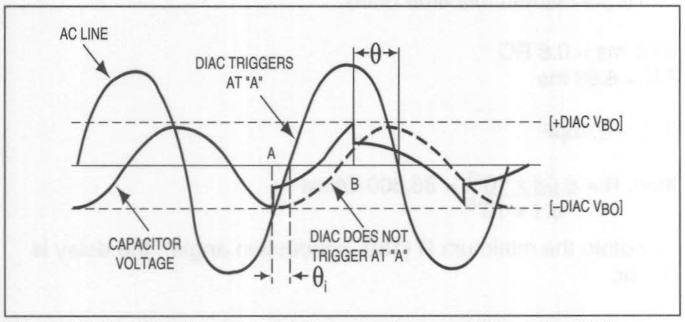


Figure 16.10 Relationship of AC Line Voltage and Triggering Voltage

In Figure 16.11, the addition of a second RC phase-shift network extends the range on control and reduces the hysteresis effect to a negligible region. This circuit will control from 5% to 95% of full load power, but is subject to supply voltage variations. When R_1 is large, C_1 is charged primarily through R_3 from the phase-shifted voltage appearing across C_2. This action provides additional range of phase-shift across C_1 and enables C2 to partially recharge C_1 after the diac has triggered, thus reducing hysteresis. R_3 should be adjusted so that the circuit just drops out of conduction when R_1 is brought to maximum resistance.

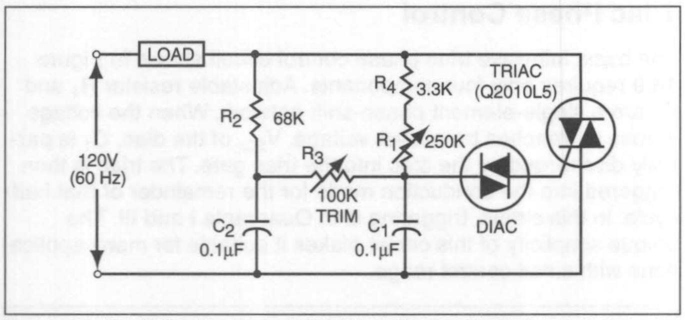


Figure 16.11 Extended Range Full Wave Phase Control

By using one of the circuits of Figure 16.12, the hysteresis effect can be eliminated entirely. The circuit of (a) in Figure 16.12 resets the timing capacitor to the same level after each positive half-cycle, providing a uniform initial condition for the timing capacitor. This circuit is only useful for resistive loads since the firing angle is not symmetrical throughout the range. If symmetrical firing is required, use the circuit of (b) in Figure 16.12.

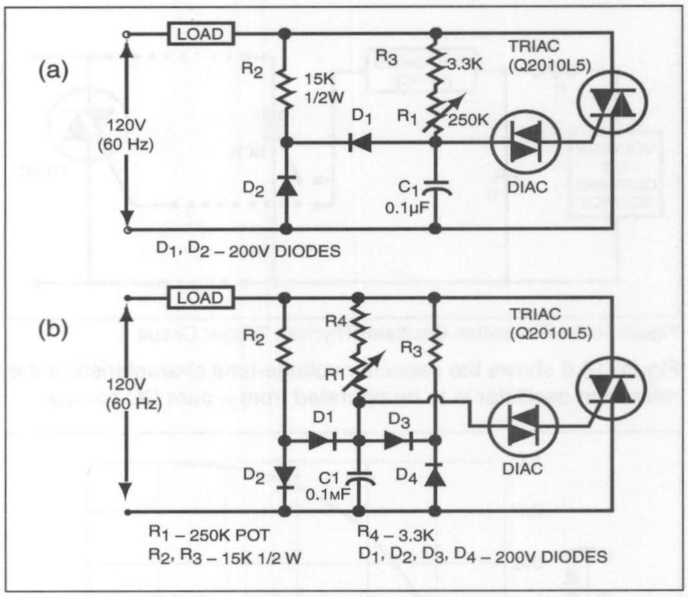


Figure 16.12 Wide Range Hysteresis Free Phase Control

For more complex control functions, particularly closed loop controls, the unijunction transistor may be used for the triggering device in a ramp and pedestal type of firing circuit as in Figure 16.13.

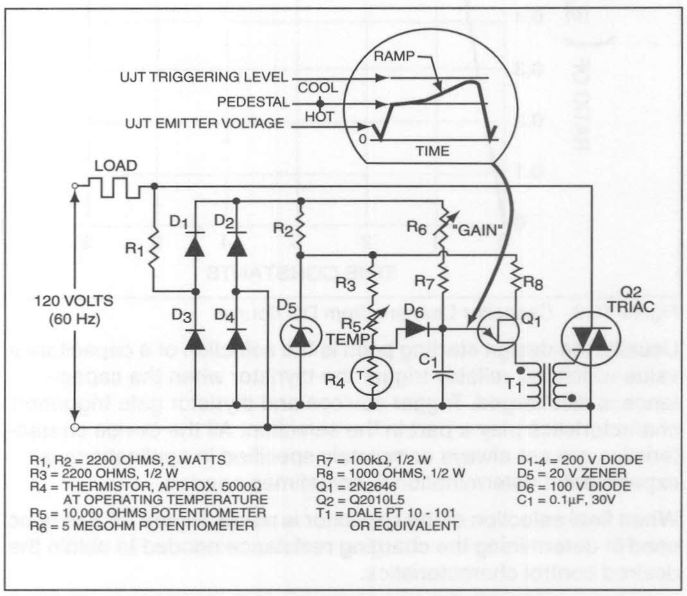
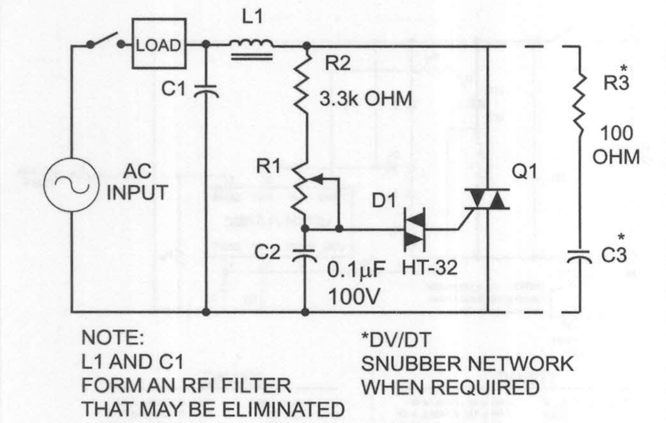


Figure 16.13 Precision Proportional Temperature Control

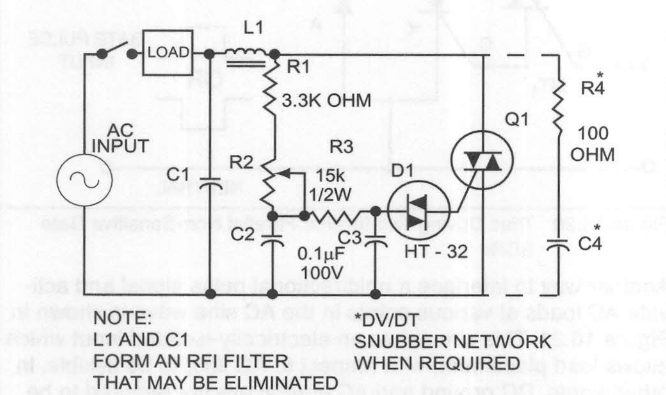
Several speed control and light dimming (phase) control circuits have been presented that give details for a complete 120V application circuit but none for 240V. The following provide some standard phase control circuits for 240V, 60Hz/50Hz operation along with 120V values for comparison. Even though there is very little difference, there are a few key things which must be remembered. First, capacitors and triacs connected across the 240V line must be rated at 400V. Secondly, the potentiometer (variable resistor) value must change considerably to obtain the proper timing or triggering for 180° in each half-cycle.

Figure 16.14 presents a simple single-time-constant light dimmer (phase control) circuit giving values for both 120V and 240V operation.



AC Input Voltage	AC Load Current	R1	C1, C3	L1	Q1
120 VAC 60Hz	12A	250K OHM	0.1µF 200V	100µH	Q2015L9
240 VAC 50/60Hz	3A	500K OHM	0.1µF 400V	200µH	Q4004L4

Figure 16.14 Single-Time-Constant Circuit for Incandescent Light Dimming, Heat Control, and Motor Speed Control



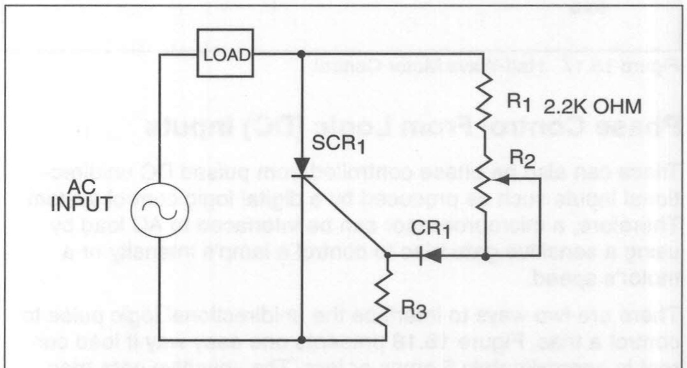
AC Input Voltage	AC Load Current	R2	C1, C2, C4	L1	Q1
120 VAC 60Hz	8A	250K OHM	0.1µF 200V	100µH	Q2010L5
240 VAC 50Hz	6A	500K OHM	0.1µF 400V	200µH	Q4008L4
240 VAC 60Hz	6A	500K OHM	0.1µF 400V	200µH	Q4008L4

Figure 16.15 Double-Time-Constant Circuit for Incandescent Light Dimming, Heat Control, and Motor Speed Control

Figure 16.15 is a double-time-constant circuit which has improved performance in comparison to Figure 16.14. This circuit uses an additional RC network to extend the phase angle so that the triac can be triggered at small conduction angles. The additional RC network also minimizes any hysteresis effect previously explained and illustrated in Figures 16.10 and 16.11.

SCR Phase Control

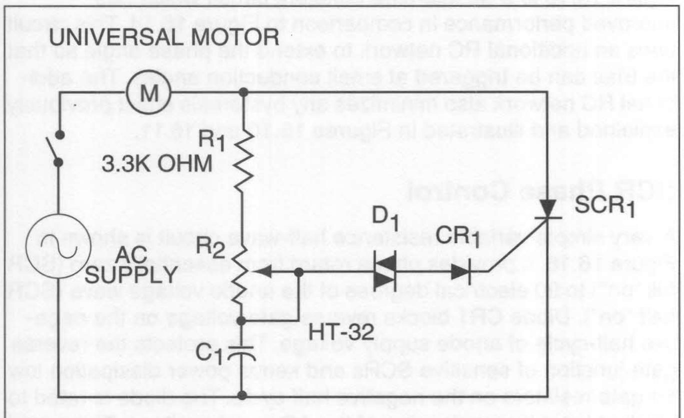
A very simple variable resistance half-wave circuit is shown in Figure 16.16. It provides phase retard from essentially zero (SCR full "on") to 90 electrical degrees of the anode voltage wave (SCR half "on"). Diode CR1 blocks reverse gate voltage on the negative half-cycle of anode supply voltage. This protects the reverse gate junction of sensitive SCRs and keeps power dissipation low for gate resistors on the negative half cycle. The diode is rated to block at least the peak value of the AC supply voltage. The retard angle cannot be extended beyond the 90 degree point because the trigger circuit supply voltage and the trigger voltage producing the gate current to fire are in phase. At the peak of the AC supply voltage, the SCR can still be triggered with the maximum value of resistance between anode and gate. Since the SCR will trigger and latch into conduction the first time I_{GT} is reached, its conduction cannot be delayed beyond 90 electrical degrees with this circuit.



AC Input Voltage	AC Load Current	R_2	CR_1	SCR_1	R_3
120 VAC 60Hz	0.8A	500K OHM	IN4003	EC103B	1KΩ
120 VAC 60Hz	8.5A	100K OHM	IN4003	S2010F1	Not Required
240 VAC 60Hz	0.8A	1MEG OHM	IN4004	EC103D	1KΩ
240 VAC 60Hz	8.5A	250K OHM	IN4004	S4010F1	Not Required
240 VAC 50Hz	2.5A	1MEG OHM	IN4004	T106D1	1KΩ

Figure 16.16 Half-Wave Control, 0-90˚ Conduction

Figure 16.17 is a half-wave phase control circuit using an SCR for controlling a universal motor. This circuit is better than simple resistance firing circuits because the phase-shifting characteristics of the RC network permit the firing of the SCR beyond the peak of the impressed voltage, resulting in small conduction angles and very slow speed.



AC Input Voltage	AC Load Current	R_2	CR_1	SCR_1	C_1
120 VAC 60Hz	8A	150K	IN4003	S2015L	0.1µF 200V
240 VAC 60Hz	6.5A	200K	IN4004	S4008L	0.1µF 400V
240 VAC 50Hz	6.5A	200K	IN4004	S4008L	0.1µF 400V

Figure 16.17 Half-Wave Motor Control

Phase Control From Logic (DC) Inputs

Triacs can also be phase controlled from pulsed DC unidirectional inputs such as produced by a digital logic control system. Therefore, a microprocessor can be interfaced to AC load by using a sensitive gate triac to control a lamp's intensity or a motor's speed.

There are two ways to interface the unidirectional logic pulse to control a triac. Figure 16.18 presents one easy way if load current is approximately 5 amps or less. The sensitive gate triac serves as a direct power switch controlled by HTL, TTL, CMOS, or integrated circuit operational amplifier. A timed pulse from the system's logic can activate the triac anywhere in the AC sinewave producing a phase controlled load.

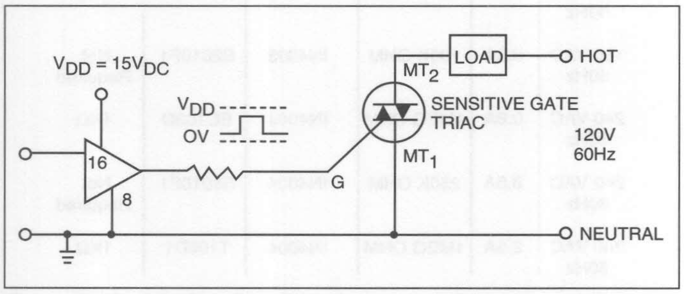


Figure 16.18 Sensitive Gate Triac Operating in Quadrants I and IV

Figure 16.19 is an example of a unidirectional (all negative) pulse furnished from a special I.C. that is available from LSI Computer Systems in Melville, New York. Even though the circuit and load is shown to control a Halogen lamp, it could be applied to a common incandescent lamp for touch controlled dimming.

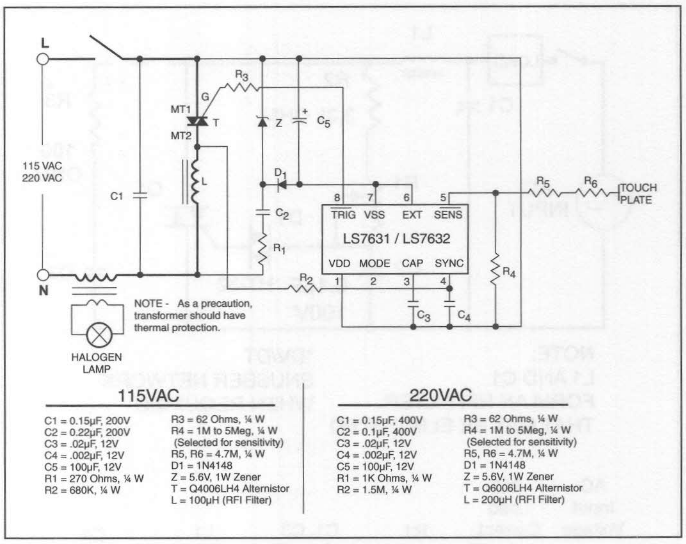


Figure 16.19 Typical Touch Plate Halogen Lamp Dimmer

For a circuit controlling heavy duty inductive loads where an Alternistor is not compatible or available. Figure 16.20 illustrates how two SCRs can be driven by an inexpensive TO-92 Triac to make a very high current Triac or Alternistor equivalent. See "Example 3: Relationship of IAV, IRMS, and IPK" in AN1009 for design calculations.

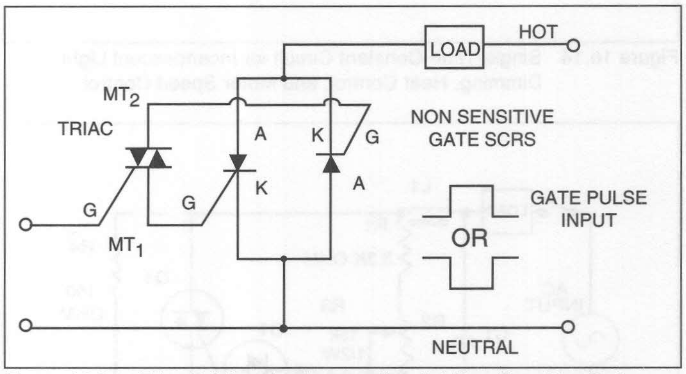


Figure 16.20 Triac Driving Two Inverse Parallel Non-Sensitive Gate SCRs

Another way to interface a unidirectional pulse signal and activate AC loads at various points in the AC sine wave is shown in Figure 16.21. This circuit has an electrically-isolated input which allows load placement, with respect to AC line, to be flexible. In other words, DC ground and AC neutral are not required to be connected.

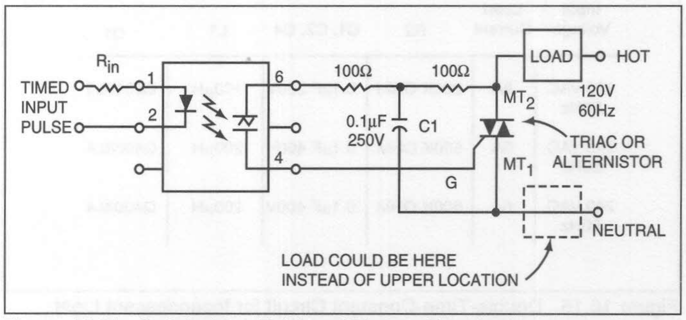


Figure 16.21 Optoisolator Driving a Triac or Alternistor

Summary

Note that the load currents that were chosen were strictly arbitrary and that the component values will be the same regardless of load current except for the power triac or SCR. The voltage rating of the power thyristor devices must be a minimum of 200V for 120V input voltage and 400V for 240V input voltage.

Also, note that the use of alternistors instead of triacs may be much more acceptable in higher current applications and may eliminate the need for any dv/dt snubber network.

For many electrical products in the consumer market, automatic control is a possibility with competitive thyristor prices and simplified circuits. These simple circuits give the designer a good feel for the nature of thyristor circuits and their design. More sophistication, such as speed and temperature feedback, can be developed as the control techniques become more familiar. A remarkable phenomenon is the degree of control obtainable with very simple circuits using thyristors. As a result, industrial and consumer products will greatly benefit both in usability and marketability.

Mounting and Handling of Semiconductor Devices

Introduction

Proper mounting and handling of semiconductor devices, particularly those used in power applications, is an important, yet sometimes overlooked, consideration in the assembly of electronic systems. Power devices need adequate heat dissipation to increase operating life and reliability and allow the device to operate within manufacturers' specifications. Also, the devices should not be abused during assembly to avoid damage to the semiconductor chip or internal assembly. Very often, device failures can be attributed directly to a heatsinking or assembly damage problem.

This application note will guide the user to the proper utilization of Teccor devices, particularly the TO-220 and TO-202 epoxy packages. These two packages are among the most popular and versatile of the many varieties available from Teccor.

This note is intended to be a basic guideline to assist the semiconductor user. For further details or suggestions on use of Teccor devices, the Teccor Applications Engineering Group is readily available to answer any inquiries.

Lead Forming—Typical Configurations

A variety of mounting configurations are possible with Teccor power semiconductor TO-202, TO-92 and TO-220 packages, depending upon power requirements, heatsinking, available space, cost considerations, etc. A few typical examples are described along with some basic design rules.

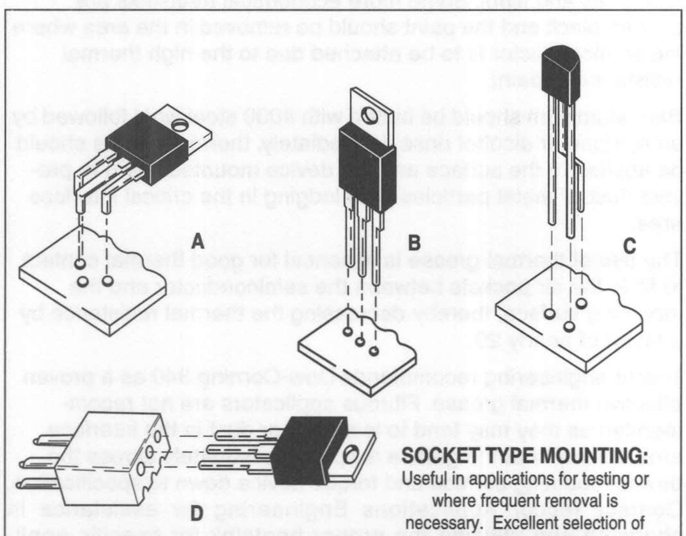


Figure 17.1 Component Mounting

These are suitable only for vibration-free environments and low-power, free-air applications. For best results, the device should be in a vertical position for maximum heat dissipation from convection currents.

Standard Lead Forms

Teccor encourages users to allow Teccor to perform all lead and tab form options for the user. Teccor has the automated machinery and expertise to produce pre-formed parts at minimum risk to the device and greater convenience for the consumer. See "Lead Form Dimensions" section for a complete list of readily available lead form options. Contact Teccor for information regarding custom lead form designs.

Lead Bending Method

Leads may be easily bent and may be bent to any desired angle, provided that the bend is made at a minimum .063" (0.1" for TO-218 package) away from the package body with a minimum radius of .032" (.040" for TO-218 package). Leads should be held firmly between the package body and the bend so that strain on the leads is not transmitted to the package body.

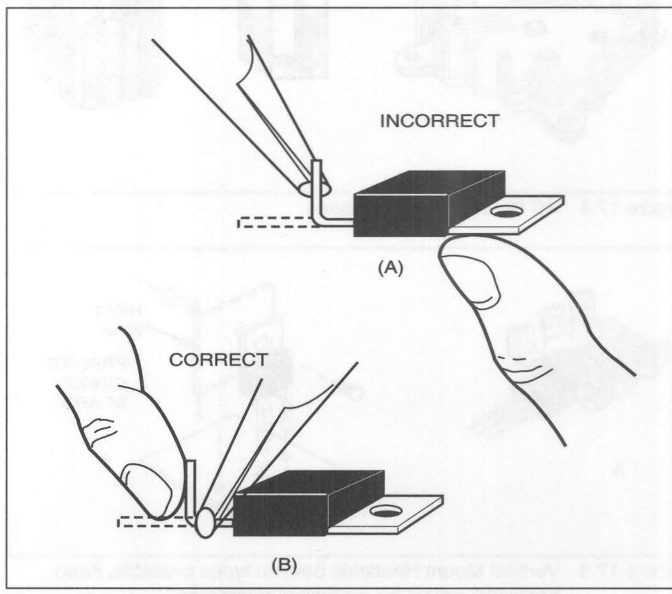


Figure 17.2 Lead Bending Method

When bending leads in the plane of the leads (spreading), bend only the narrow part. Sharp angle bends should be done only once as repetitive bending will fatigue and break the leads.

The mounting tab of the TO-202 Package may also be bent or formed into any convenient shape so long as it is held firmly between the plastic case and the area to be formed or bent. Without this precaution, bending the tab may fracture the chip and permanently damage the unit.

Heatsinking

Use largest, most efficient heatsink as practical and cost effective to extend device life and increase reliability. Many power device failures are a direct result of improper heat dissipation. Heatsinks that have a mating area smaller than the metal tab of the device

are unacceptable. Heatsinking material should be at least .062" thick to be effective and efficient.

Note that in all applications the maximum case temperature (T_C) rating of the device must not be exceeded. Refer to the individual device data sheet rating curves (T_C vs I_T) as well as the individual device outline drawings for correct T_C measurement point.

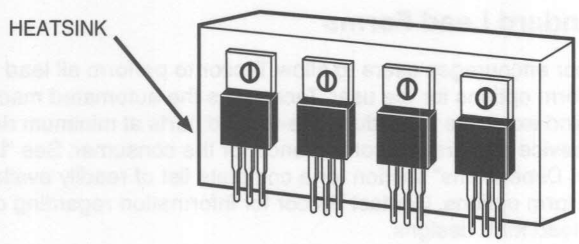


Figure 17.3 Several TO-220 THERMOTAB Devices Mounted to a Common Heatsink. All are electrically isolated from each other.

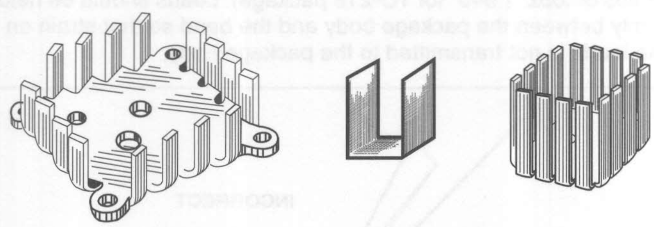


Figure 17.4 PC Board Mount Examples

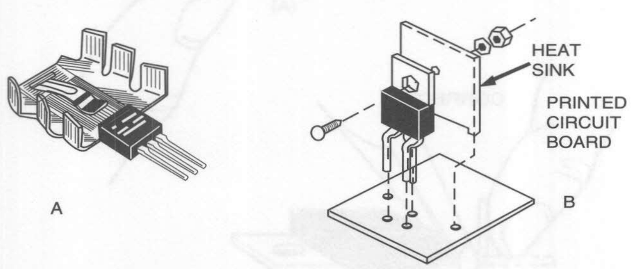


Figure 17.5 Vertical Mount Heatsink: Several types available. Keep heatsink vertical for maximum convection.

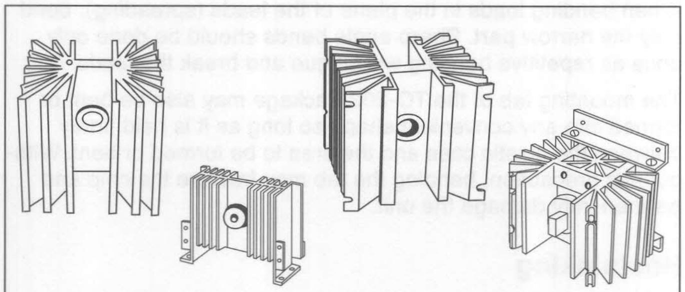


Figure 17.6 Extruded Aluminum Examples: When coupled with fans, these types have the highest efficiency.

Heatsinking Notes

Care should be taken not to mount heatsinks near other heat-producing elements such as power resistors. Black anodized heatsinks may absorb more heat than they dissipate this way.

Some heatsinks can hold several power devices. Make sure that if they are in electrical contact to the heatsink, the devices do not short-circuit the desired functions. Isolate the devices electrically or move to another location. Recall that the mounting tab of Teccor isolated THERMOTAB devices is electrically isolated so that several devices may be mounted on the same heatsink without extra insulating components.

Allow for adequate ventilation. Route heatsinks to outside of assembly for maximum airflow, if possible.

Mounting Surface Selection

Proper mounting surface selection is essential to efficient transfer of heat from the semiconductor device to the heatsink and from the heatsink to the ambient. The most popular heatsinks are flat aluminum plates or finned extruded aluminum heatsinks.

The mounting surface should be clean and free from burrs or scratches. It should be flat within .002 in/inch and a surface finish of 30 to 60 microinches is acceptable. Surfaces with a higher degree of polish do not produce better thermal conductivity.

Many aluminum heatsinks are black anodized to improve thermal emissivity and prevent corrosion. Anodizing results in high electrical but negligible thermal insulation. This is an excellent choice for isolated TO-220 THERMOTAB devices. For applications of TO-202AB devices where electrical connection to the common anode tab is required, the anodization should be removed. Iridite or chromate acid dip finish offers low electrical and thermal resistance. Either TO-202AB or isolated THERMOTAB devices may be mounted directly to this surface, regardless of application. Both finishes should be cleaned prior to use to remove manufacturing oils and films. Some more economical heatsinks are painted black and the paint should be removed in the area where the semiconductor is to be attached due to the high thermal resistance of paint.

Bare aluminum should be buffed with #000 steel wool followed by an acetone or alcohol rinse. Immediately, thermal grease should be applied to the surface and the device mounted down to prevent dust or metal particles from lodging in the critical interface area.

The use of thermal grease is essential for good thermal contact to fill in the air pockets between the semiconductor and the mounting surface, thereby decreasing the thermal resistance by a factor of nearly 20.

Teccor engineering recommends Dow-Corning 340 as a proven effective thermal grease. Fibrous applicators are not recommended as they may tend to leave lint or dust in the interface area. Assure that the grease is spread adequately across the device mounting surface and torque device down to specification. Contact Teccor Applications Engineering for assistance in choosing and utilizing the proper heatsink for specific application.

Hardware And Methods

TO-220AB

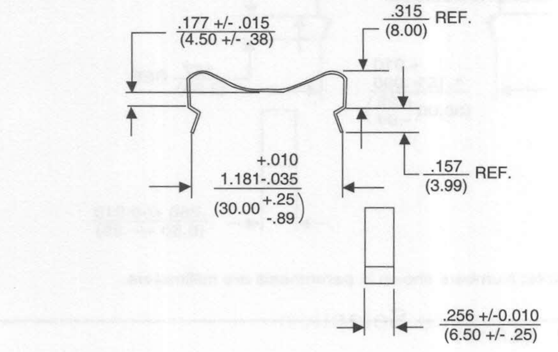


Figure 17.7 TO-220AB

The mounting hole for the Teccor TO-220AB devices should not exceed .140 (6/32) clearance. No insulating bushings are needed for the "L" Package (isolated) devices as the tab is electrically isolated from the semiconductor chip. 6/32 mounting hardware, especially round head or Fillister machine screws, are recommended and should be torqued to a value of 6.0 inch-lbs.

Punched holes are not acceptable due to cratering around the hole which can cause the device to be pulled into the crater by the fastener or can leave a significant portion of the device out of contact with the heatsink. The first effect may cause immediate damage to the package and early failure while the second can create higher operating temperatures which will shorten operating life. Punched holes are quite acceptable in thin metal plates where fine edge blanking or sheared-through holes are employed.

Drilled holes must have a properly prepared surface. Excessive chamfering is not acceptable as it may create a similar crater effect as above. Edges must be deburred to promote good contact and avoid puncturing isolation materials.

For high voltage applications, it is recommended that only the metal portion of the TO-220 package (as viewed from the bottom of the package) be in contact with the heatsink to provide maximum oversurface distance to prevent a high voltage path over the plastic case to a grounded heatsink.

TO-202

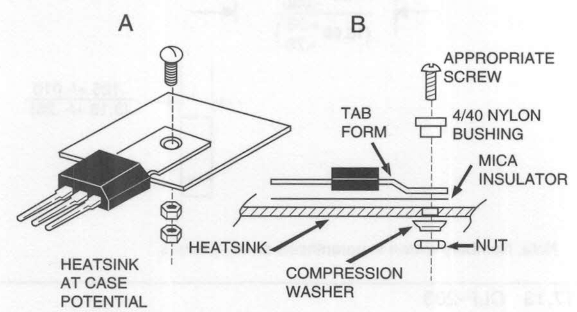


Figure 17.8 TO-202

The mounting hole should not exceed .112 (4/40) clearance. Since tab is electrically common with anode, heatsink may or may not need to be electrically isolated from tab. If not, use 4/40 screw with lock washer and nut.

Mounting torque is 6 inch-lbs.

A nylon bushing and mica insulation are required to insulate the tab in an isolated application. A compression washer is recommended to avoid damaging the bushing. Do not attempt to mount non-formed tabs to a plane surface as the resulting strain on the case may cause it or the semiconductor chip assembly to fail. Teccor has the facilities and expertise to properly tab form TO-202 devices for the convenience of the consumer.

TO-218

The mounting hole for the TO-218 device should not exceed .164 (8/32) clearance. Isolated versions of TO-218 do not require any insulating material since mounting tab is electrically isolated from the semiconductor chip. Round lead or Fillister machine screws are recommended. Maximum torque to be applied to mounting tab is 8.0 inch-lbs.

The same precautions given for the TO-220 package apply to the TO-218 package concerning punched holes, drilled holes, and proper prepared heatsink mounting surface. Also for high voltage applications, it is recommended that only the metal portion of the mounting surface of TO-218 package be in contact with heatsink in order to achieve maximum oversurface distance to prevent a high voltage path over the device body to grounded heatsink.

General Mounting Notes

Care must be taken on both packages at all times to avoid strain to the tab or leads. Axial strain on the leads should be avoided. Mounting holes for the tab and the leads should be carefully measured and any forming of the tab or leads should be done beforehand for easy insertion of the part onto the board or heatsink. Refer to the section on Lead Forming before attempting lead form operations.

"POP" RIVETING TECHNIQUE

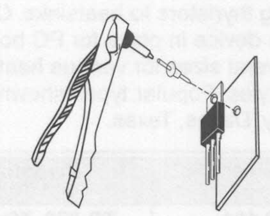


Figure 17.9 "Pop" Riveting Technique

For less demanding and more economical applications, rivets may be used. 1/8" all aluminum "pop" rivets can be used on both TO-220 and TO-202 packages. Use a .129" – .133" (#30) drill for the hole and insert the rivet from the top side. An insertion tool, similar to a "USM" PRG 430 hand riveter, is recommended. A wide selection of grip ranges is available, depending upon the thickness of the heatsink material. Use an appropriate grip range to securely anchor the device, yet not deform the mounting tab. The recommended rivet tool has a protruding nipple that will allow easy insertion of the rivet and keep the tool clear from the plastic case of the device.

A “Milford” #511 (Milford Group, Milford, CT) semi-tubular steel rivet set into a .129" receiving hole with a riveting machine similar to a “Milford” S256 is also very acceptable. Contact the rivet machine manufacturer for exact details on application and set-up for optimum results.

Pneumatic or other impact riveting devices are not recommended due to the shock they may apply to the device.

Under no circumstance should any tool or hardware come into contact with the case. The case should not be used as a brace for any rotation or shearing force during mounting or in use. Non-standard size screws, nuts, and rivets are easily obtainable to avoid clearance problems.

Always use an accurate torque wrench to mount devices. No gain may be achieved by overtorquing devices. In fact, over-torque may cause the tab and case to deform or rupture, seriously damaging the device. The curve below illustrates the effect of proper torque. See Figure 17.10.

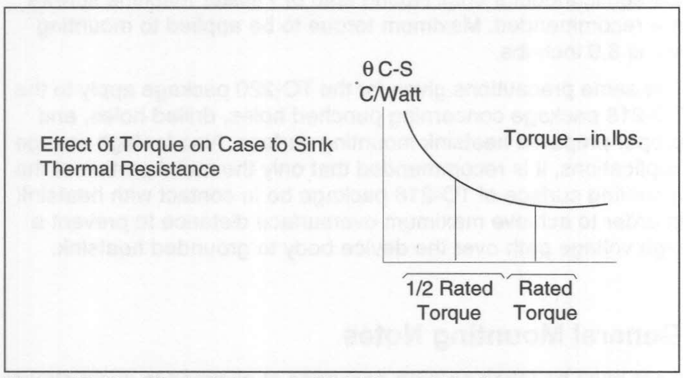


Figure 17.10 Effect of Torque to Sink Thermal Resistance

With proper care, the mounting tab of a device can be soldered to a surface. The heat required to accomplish this operation can damage or destroy the semiconductor chip or internal assembly. For spring clips, see “Surface Mount Soldering Recommendations” (AN1005) in this catalog.

Spring-steel clips can be used to replace torqued hardware in assembling thyristors to heatsinks. Clips snap into heatsink slots to hold the device in place for PC board insertion. Clips are available in several sizes for various heatsink thicknesses and thyristor case styles. Popular types shown are available from Thermalloy, Dallas, Texas.

Spring-steel Clip Part Number	Thyristor Case Style	Heatsink Material Thickness in Inches
CLP-101	TO-220, TO-218	.050-.080
CLP-201	TO-220	.050-.080
CLP-202	TO-220	.090-.125
CLP-203	TO-220	.050-.080

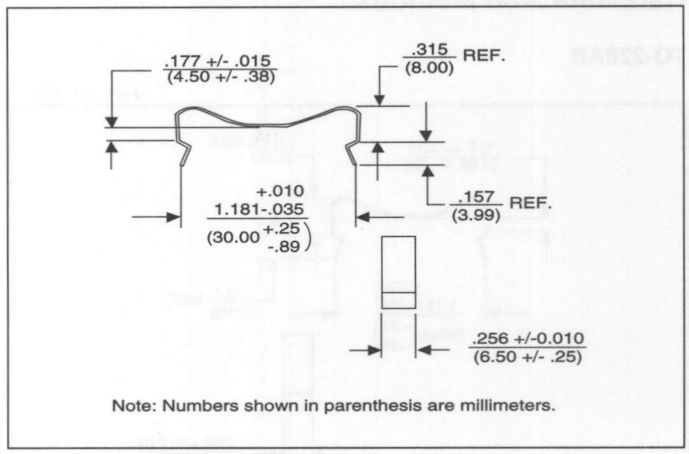


Figure 17.11 CLP-101

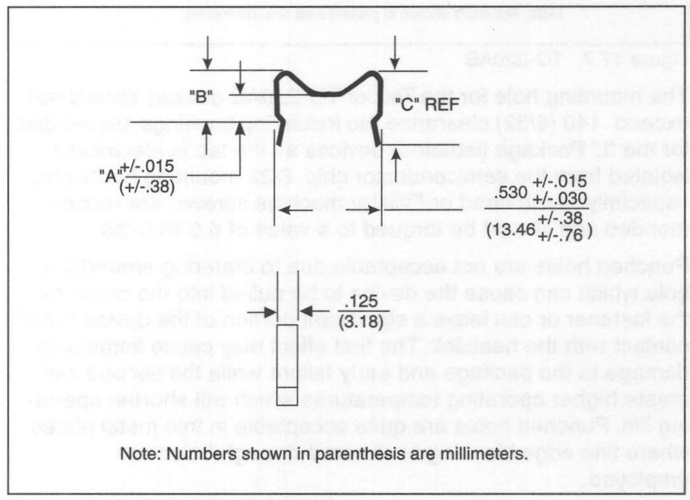


Figure 17.12 CLP-201, CLP-202

Catalog No.	Dim “A”	Dim “B”	Dim “C”
CLP-201	.165 (4.19)	.350 (8.89)	.535 (13.59)
CLP-202	.225 (5.72)	.410 (10.41)	.595 (15.11)

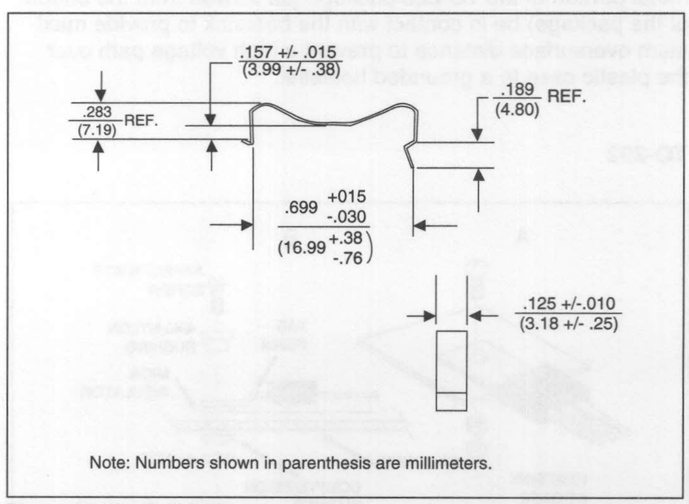


Figure 17.13 CLP-203

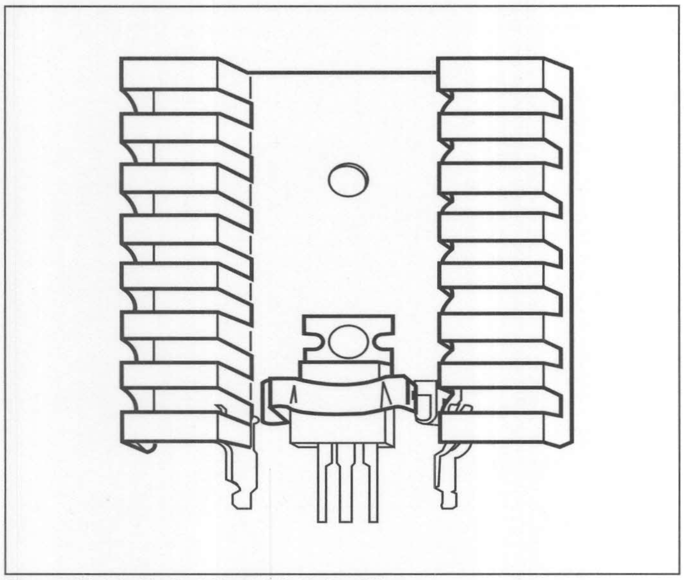


Figure 17.14 Typical Heatsink Using Clips

Soldering Of Leads

A prime consideration is the soldering of device leads into PC boards, heatsinks, etc. Significant damage can be done to the device through improper soldering. In any soldering process, do not exceed the data sheet lead solder temperature of +230°C for 10 seconds, maximum, ≥1/16" from the case.

Three types of soldering will be discussed: hand soldering, wave soldering, and dip soldering.

Hand Soldering

This method is mostly used in prototype breadboarding applications and production of small modules. It has the greatest potential for misuse. The following recommendations apply to Teccor TO-92, TO-202, TO-220, and TO-218AC packages.

Select a small to medium duty electric soldering iron of 25 to 45 watts designed for electrical assembly application. Tip temperature should be rated at 600°- 800° F (300°C-425°C). The iron should have sufficient heat capacity to heat the joint quickly and efficiently in order to minimize contact time to the part. Pencil tip probes work very well. Heavy duty electrical irons of greater than 45 watts or flame-heated irons and large heavy tips are not recommended as their tip temperatures are far too high and uncontrollable and can easily exceed the time-temperature limit of the part.

Teccor FASTPAK devices require a different soldering technique.

Circuit connection can be done by either quick-connect terminals or solder.

Since most quick-connect .250 female terminals have a maximum rating of 30 Amps, connection to terminals should be made by soldering wires instead of quick-connects.

A number 10 AWG stranded wire is recommended to be used for MT1 and MT2 for load currents above 30 Amps. Soldering should be performed with 100 watt soldering iron which should not remain in contact with the wire and terminal longer than 40 seconds, so as not to damage the Fastpak triac.

The following 3-terminal quick-connect connector plug, or equivalent, is recommended for use with this package. Check connector manufacturer's data sheet for proper usage.

Load Current	P/N
25 amps MAX	AMP 172410-1 (Housing)
	AMP 63239-1 (.250 Receptacle)
	AMP 63195-1 (.187 Receptacle)

For the new Teccor TO-218X package, the basic rules as described before apply; however, a larger iron may be required to apply sufficient heat to the larger leads to efficiently solder the joint.

Again do not exceed the lead solder temperatures of +230˚C for 10 seconds, maximum, ≥1/16" (1.59mm) from the case.

A 60/40 or 63/37 Sn/Pb solder is acceptable. This low melting point solder used in conjunction with a mildly activated rosin flux is recommended.

The device should be inserted into the board or socket and, if required, the device attached to the heatsink first. Each lead should be individually heatsinked as it is soldered. Commercially available heatsink clips are excellent for this use. Hemostats may also be used if available. Needle-nose pliers are a good heatsink choice; however, they are not as handy as stand-alone-type clips.

In any case, the lead should be clipped or grasped between the soldier joint and the case as near to the joint as possible. Avoid straining or twisting the lead in any way.

Use a clean pre-tinned iron and solder the joint as quickly as possible. Avoid overheating the joint or bringing the iron or solder into contact with other unheatsinked leads.

Wave Solder

This is one of the most efficient methods of soldering large numbers of PC boards quickly and effectively. Guidelines for soldering by this method are supplied by equipment manufacturers. Points to be emphasized are that the boards should be preheated to avoid thermal shock to semiconductor components and the time-temperature cycle in the solder wave should be regulated to avoid heating the device beyond the recommended temperature rating. A mildly activated resin flux is recommended. See Figure 17.15 for typical heat and time conditions.

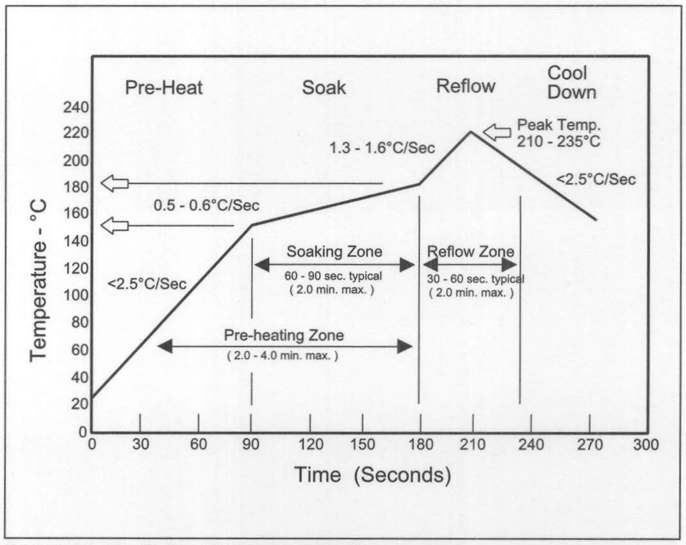


Figure 17.15 Reflow Soldering with Pre-Heating

Dip Soldering

This is very similar to wave soldering, but is a hand operation. The same considerations as above should be followed, particularly the time-temperature cycle which may become operator dependent. Due to the wide process variations that may occur, this method is not recommended.

Board or device clean-up is left to the discretion of the customer. Teccor devices are tolerant to a wide variety of solvents. They conform to MIL-STD 202E method 215 "Resistance to Solvents."

Surface Mount Soldering Recommendations

The most important consideration in reliability is achieving a good solder bond between surface mount device (SMD) and substrate since the solder provides the thermal path from the chip. A good bond is less subject to thermal fatiguing and will result in improved device reliability.

The most economic method of soldering is a process in which all different components are soldered simultaneously; for example: DO-214AA devices, capacitors and resistors.

Reflow Of Soldering

The preferred technique for mounting microminiature components on hybrid thick- and thin-film is the method of reflow soldering.

The DO-214AA is designed to be mounted directly to or on thick-film metallization which has been screened and fired on a substrate.

Recommended substrates: Alumina or P.C. Board material.

Recommended metallization: Silver palladium or molymanganese (plated with nickel or other elements to enhance solderability). For more information, consult Du Pont's Thick-Film handbook or the factory.

It is best to prep the substrate by either dipping the substrate in a solder bath or by screen printing a solder paste.

After the substrate is prepared, devices are put in place with vacuum pencils. The device may be laid in place without special alignment procedures since it is self-aligning during solder reflow process and will be held in place by surface tension.

For reliable connections, it should be kept in mind that:

(1) The maximum temperature of the leads or tab during the soldering cycle does not exceed 275°C.

(2) The flux must affect neither components nor connectors.

(3) The residue of the flux must be easy to remove.

Good flux or solder paste with these properties is available on the market.

A recommended flux is Alpha 5003 diluted with benzyl alcohol. Dilution used will vary with application and must be determined empirically.

Having first been fluxed, all components are positioned on the substrate. The slight adhesive force of the flux is sufficient to keep the components in place.

Solder paste contains a flux and, therefore, has good inherent adhesive properties which eases positioning of the components.Allow flux to dry at room temperature or in a 70°C oven. Flux should be dry to the touch. Time required will depend on flux used.

With the components in position, the substrate is heated to a point where the solder begins to flow. This can be done on a heating plate, on a conveyor belt running through an infrared tunnel, or by using vapor phase soldering.

In the vapor phase soldering process, the entire PC board is uniformly heated within a vapor phase zone at a temperature of approximately 215°C. The saturated vapor phase zone is obtained by heating an inert (inactive) fluid to the boiling point. The vapor phase is locked in place by a secondary vapor. (See Figure 18.1.) Vapor phase soldering provides uniform heating and prevents overheating.

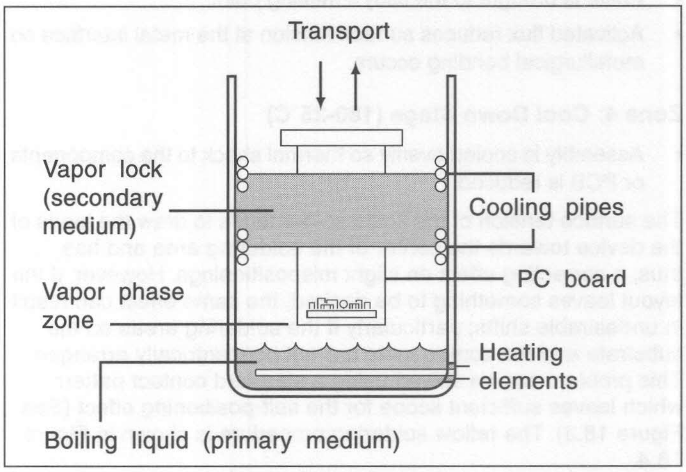


Figure 18.1 Principle of Vapor Phase Soldering

No matter which method of heating is used, the maximum allowed temperature of the plastic body must not exceed 250°C during the soldering process. For further temperature behavior during the soldering process, see Figures 18.2 and 18.3.

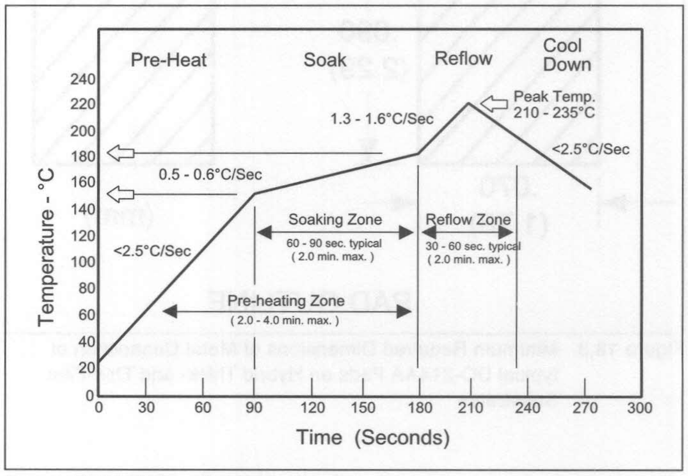


Figure 18.2 Reflow Soldering Profile

Reflow Soldering Zones

Zone 1: Initial Pre-Heating Stage (25-150˚C)

- Excess solvent is driven off.
- PCB and Components are gradually heated up.
- Temperature gradient shall be < 2.5˚C/Sec.

Zone 2: Soak Stage (150-180˚C)

- Flux components start activation and begin to reduce the oxides on component leads and PCB pads.
- PCB components are brought nearer to the temperature at which solder bonding can occur.
- Allows different mass components to reach the same temperature.
- Activated flux keeps metal surfaces from re-oxidizing.

Zone 3: Reflow Stage (180-235˚C)

- Paste is brought to the alloy's melting point.
- Activated flux reduces surface tension at the metal interface so metallurgical bonding occurs.

Zone 4: Cool Down Stage (180-25˚C)

- Assembly is cooled evenly so thermal shock to the components or PCB is reduced.

The surface tension of the liquid solder tends to draw the leads of the device towards the center of the soldering area and has, thus, a correcting effect on slight mispositionings. However, if the layout leaves something to be desired, the same effect can result in undesirable shifts; particularly if the soldering areas on the substrate and the components are not concentrically arranged. This problem can be solved using a standard contact pattern which leaves sufficient scope for the self-positioning effect (See Figure 18.3). The reflow soldering procedure is shown in Figure 18.4.

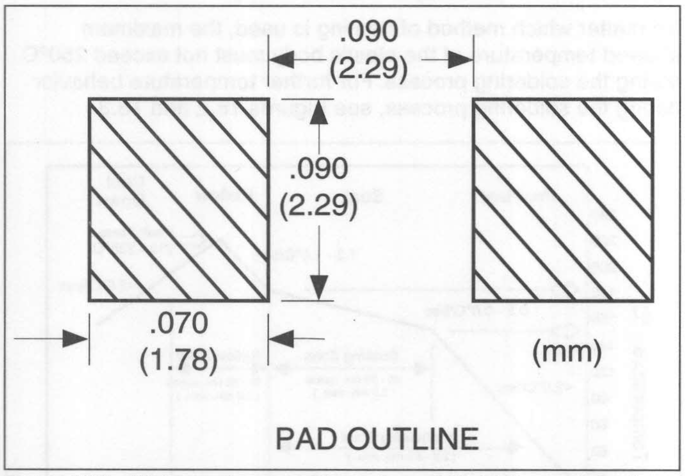


Figure 18.3 Minimum Required Dimensions of Metal Connection of typical DO-214AA Pads on Hybrid Thick- and Thin-Film Substrates

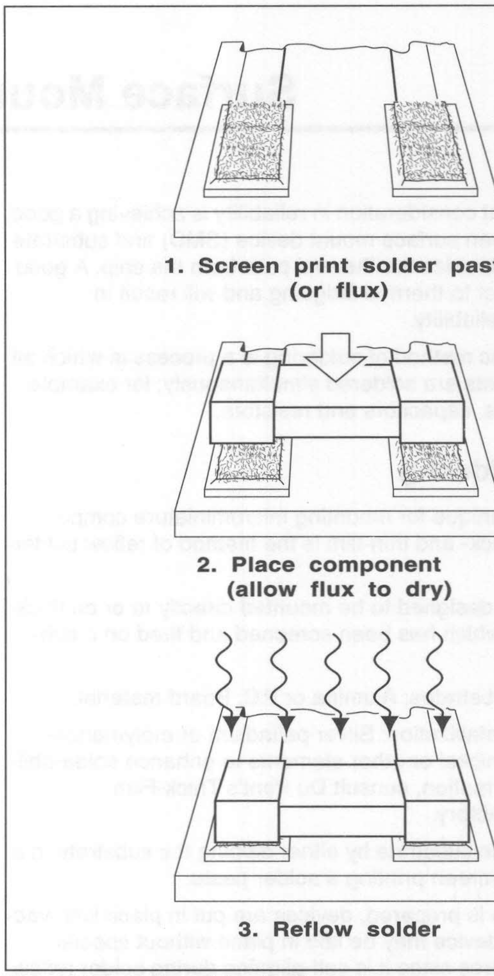


Figure 18.4 Reflow Soldering Procedure

After the solder has set and cooled, the connections are visually inspected and, where necessary, put right with a soldering iron. Finally the remnants of the flux must be removed carefully.

Use vapor degrease with an azeotrope solvent or equivalent to remove flux. Allow to dry.

After drying procedure is complete, the assembly is ready for testing and/or further processing.

Wave Soldering

Wave soldering is the most commonly used method for soldering components in PCB assemblies. As with other soldering processes, a flux is applied before soldering. After the flux is applied, the surface mount devices are glued into place on a PC board. The board is then placed in contact with a molten wave of solder at a temperature between 240°C-260°C which affixes the component to the board. Dual wave solder baths are also in use. This procedure is the same as mentioned above except a second wave of solder removes excess solder. Although wave soldering is the most popular method of PCB assembly, there are some drawbacks. The negative features include solder bridging and shadows (pads and leads not completely wetted) as board density increases, as well as this method having the sharpest thermal gradient. To prevent thermal shock, some sort of pre-heating device must be used. Procedures for wave soldering PCBs with (a) surface mount devices only and (b) both surface mount and leaded components are shown in Figures 18.5 and 18.6.

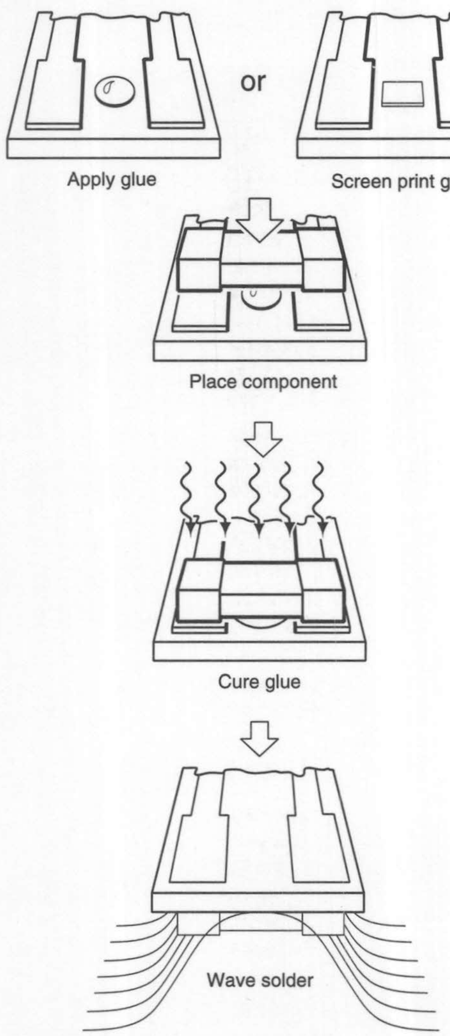


Figure 18.5 Wave Soldering PCBs With Surface Mount Devices Only

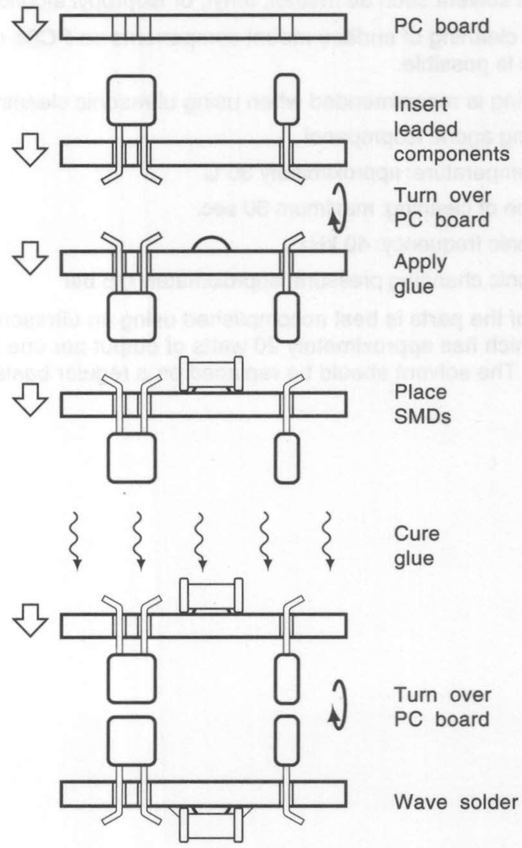


Figure 18.6 Wave Soldering PCBs With Both Surface Mount and Leaded Components

Immersion Soldering

Maximum allowed temperature of the soldering bath is 235°C. Maximum duration of soldering cycle is 5 seconds and forced cooling must be applied.

Hand Soldering

It is possible to solder the DO-214AA devices with a miniature hand-held soldering iron, but this method has particular drawbacks and should, therefore, be restricted to laboratory use and/ or incidental repairs on production circuits.

Recommended Metal-alloy

(1) 63/37 Sn/Pb
(2) 60/40 Sn/Pb

Pre-Heating

Pre-heating is recommended for good soldering and avoiding damage to the DO-214AA devices, other components and the substrate. Maximum pre-heating temperature is 165°C while the maximum pre-heating duration may be 10 seconds. However, atmospheric pre-heating is permissible for several minutes provided temperature does not exceed 125°C.

Gluing Recommendations

Prior to wave soldering, surface mount devices (SMD) must be fixed to the PCB or substrate by means of an appropriate adhesive. The adhesive (in most cases a multicomponent adhesive) has to fulfill the following demands:

- Uniform viscosity to ensure easy coating
- No chemical reactions upon hardening in order not to deteriorate component and PC board.
- Straightforward exchange of components in case of repair.

Cleaning Recommendations

PC board or substrate cleaning in solvents is permitted at approximately 70˚C to 80˚C.

The soldered parts should be cleaned with azeotrope solvent followed by a solvent such as methol, thhyl, or isopropyl alcohol.

Ultrasonic cleaning of surface mount components on PCBs or substrates is possible.

The following is recommended when using ultrasonic cleaning:

- Cleaning agent: Isopropanol
- Bath temperature: approximately 30˚C
- Duration of cleaning: maximum 30 sec.
- Ultrasonic frequency: 40 kHz
- Ultrasonic changing pressure: approximately 0.5 bar

Cleaning of the parts is best accomplished using an ultrasonic cleaner which has approximately 20 watts of output per one liter of solvent. The solvent should be replaced on a regular basis.

AN1006

Testing Teccor Semiconductor Devices Using Curve Tracers

Introduction

One of the most useful and versatile instruments for testing semiconductor devices is the curve tracer (CT). The best known manufacturer of curve tracers is TEKTRONIX, which produces four basic models: the 575, 576, 577 and 370. These instruments are specially adapted CRT display screens with associated electronics such as power supplies, amplifiers, and variable input and output functions that allow the user to display the operating characteristics of a device in an easy-to-read, standard graph form. Operation of TEKTRONIX CTs is simple and straightforward and easily taught to non-technical personnel. Although widely used by semiconductor manufacturers for design and analytical work, the device consumer will find many uses for the curve tracer such as incoming quality control, failure analysis, and supplier comparison. Curve tracers may be easily adapted for go-no go production testing. TEKTRONIX also supplies optional accessories for specific applications along with other useful hardware.

TEKTRONIX Equipment

TEKTRONIX produces four curve tracer models: the 575, 576, 577 and 370. The 575 is no longer in production; however, many units are still operating in the field and it is still an extremely useful instrument. The 576, 577 and 370 are current models and are more streamlined in their appearance and operation. The 577 is a less elaborate version of the 576, yet retains all necessary test functions.

The following basic functions are common to all curve tracers:

- Power Supply—supplies positive DC voltage, negative DC voltage, or AC voltage to bias the device. Available power is varied by limiting resistors.
- Step Generator—supplies current or voltage in precise steps to control the electrode of the device. The number, polarity and frequency of steps are selectable.
- Horizontal Amplifier—displays power supply voltage as applied to the device. Scale calibration is selectable.
- Vertical Amplifier—displays current drawn from the supply by the device. Scale calibration is selectable.

Also present are controls for beam position, calibration, pulse operation, and others that vary from model to model. The basic theory of operation is that for each curve one terminal is driven with a constant voltage or current and the other one is swept with a half sinewave of voltage. The driving voltage is stepped through several values and a different trace is drawn on each sweep to generate a family of curves.

Limitations, Accuracy, and Correlation

Although the curve tracer is a highly versatile device, it is not capable of every test that one may wish to perform on semiconductor devices such as dv/dt, secondary reverse breakdown, switching speeds, and others. Also, tests at very high currents and/or voltages are difficult to make accurately and avoid damaging the devices. A special high current test fixture available from TEKTRONIX can extend operation to 200A pulsed peak. Kelvin contacts available on the 576 and 577 eliminate inaccuracy in voltage measured at high current (V_{TM}) by sensing voltage drop due to contact resistance and subtracting from the reading.

Accuracy of the unit is within the published manufacturer's specification. The curve tracer should be allowed to warm-up and stabilize before testing begins. Always expand the horizontal or vertical scale as far as possible to increase the resolution. Be judicious in recording data from the screen, as the trace line width and scale resolution factor somewhat limit the accuracy of what may be read. Regular calibration checks of the instrument are recommended. Some users keep a selection of calibrated devices on hand to verify instrument operation when in doubt. Re-calibration or adjustment should be performed only by qualified personnel.

Often discrepancies exist between measurements taken on different types of instrument. In particular, most semiconductor manufacturers use high-speed, computerized test equipment to test devices. They test using very short pulses. If a borderline unit is then measured on a curve tracer, it may appear to be out of specification. The most common culprit here is heat. When a semiconductor device increases in temperature due to current flow, certain characteristics may change, notably gate characteristics on SCRs, gain on transistors, leakage, etc. It is very difficult to operate the curve tracer in such a way as to eliminate the heating effect. Pulsed or single trace operation will help to reduce this problem, but care should be taken in comparing curve tracer measurements to computer tests. Other factors which may create differences are stray capacitances, impedance matching, noise, and device oscillation.

The following test procedures have been written with the use of the model 576 curve tracer in mind. An appendix follows to describe the minor changes that are required to use the model 577 curve tracer. The standard 575 model lacks AC mode, voltage greater than 200V, pulse operations, DC mode, and step offset controls. The 575 MOD122C does allow voltage up to 400V, including 1500V in an AC mode.

It must be remembered that the 575 was designed at the time only to test transistors and diodes. Some ingenuity, experience, and external hardware may be required to test other types of devices.

For further information or assistance in device testing on TEKTRONIX curve tracers, contact the Teccor Applications Engineering group.

Safety (Cautions and Warnings)

The TEKTRONIX safety rules supplied with each curve tracer should be adhered to rigidly. No attempt should be made to defeat any of the safety interlocks on the device as the curve tracer can produce a lethal shock. Also older 575 models do not

have the safety interlocks as do the new models. Care should be taken to never touch any device or open the terminal while energized.

WARNING: Devices may be easily damaged on the curve tracer from electrical overstress.

Follow these rules to avoid destroying devices:

- Familiarize yourself with the expected maximum limits of the device.
- Limit the current with the variable resistor to the minimum necessary to conduct the test.
- Increase power slowly to the specified limit.
- Watch for device "runaway" due to heating.
- Apply and increase gate or base drive slowly and in small steps.
- Conduct tests in the minimum time required.

General Test Procedures

Read all manuals before operating a curve tracer.

Perform the following manufacturer's equipment check:

1. Turn on and warm up curve tracer, but turn off, or down, all power supplies.
2. Correctly identify terminals of the device to be tested. Consult the manufacturer's guide if necessary.
3. Insert the device into the test fixture, matching the device and test terminals.
4. Remove hands from the device and/or close interlock cover.
5. Apply required bias and/or drive.
6. Record results as required.
7. Disconnect all power to the device before removing.

Power Rectifiers

The rectifier is a unidirectional device which conducts when forward voltage (above 0.7 volts) is applied.

To connect the rectifier:

1. Connect *Anode* to *Collector Terminal (C)*.
2. Connect *Cathode* to *Emitter Terminal (E)*.

To begin testing, perform the following procedures.

Procedure 1: V_{RRM} and I_{RM}

To measure the V_{RRM} and I_{RM} parameter:

1. Set *Collector Voltage Supply Range* to *1500 volts*.
2. Set *Horizontal* knob to sufficient scale to allow viewing of trace at the required voltage level (100 volts/DIV) for 400 & 600 volt devices and 50 volts/DIV for 200 volt devices).
3. Set *Mode* to *Leakage*.
4. Set *Vertical* knob to *100 microamps/DIV.* (Due to leakage setting, the CRT readout will be 100nA per division.)
5. Set *Terminal Selector* to *Emitter Grounded-Open Base*.
6. Set *Polarity* to (–).
7. Set *Power Dissipation* to *2.2 watts*.
8. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
9. Increase *Variable Collector Supply Voltage* to the rated V_{RRM} of the device and observe the dot on the CRT. Read across horizontally from the dot to the vertical current scale. This measured value will be the leakage current. (See Figure 19.1.)

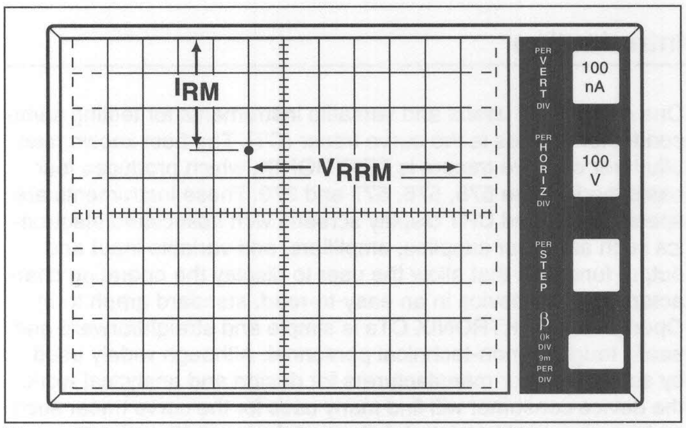


Figure 19.1 I_{RM} is equal to 340nA at V_{RRM} equal to 600

Procedure 2: V_{FM}

Before testing, note the following:

- A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of VFM will result due to voltage drop in fixture. If a Kelvin fixture is not available, see the attached instructions for necessary information to wire a test fixture with Kelvin connections.
- Due to the current limitations of standard curve tracer model 576, V_{FM} cannot be tested at rated current without a TEKTRONIX model 176 high-current module. The procedure below is done at $I_{T(RMS)}$ = 10 amps (20 APK). This test parameter will allow the use of a standard curve tracer and still provide an estimate of whether V_{FM} is within spec.

To measure the V_{FM} parameter:

1. Set *Collector Voltage Supply Range* to *15 Max Peak volts* .
2. Set *Horizontal* knob to *0.5 volts/DIV.*
3. Set *Mode* to *Norm.*
4. Set *Vertical* knob to *2 amps/DIV.*
5. Set *Power Dissipation* to *220 watts* (*100 watts* on 577).
6. Set *Polarity* to (+).
7. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture .
8. Increase *Variable Collector Supply Voltage* until current reaches 20 amps.

WARNING: Limit test time to 15 seconds maximum.

To measure V_{FM}, follow along horizontal scale to the point where the trace crosses the 20 amp axis. The distance from the left-hand side of scale to the crossing point is the V_{FM} value (See Figure 19.2).

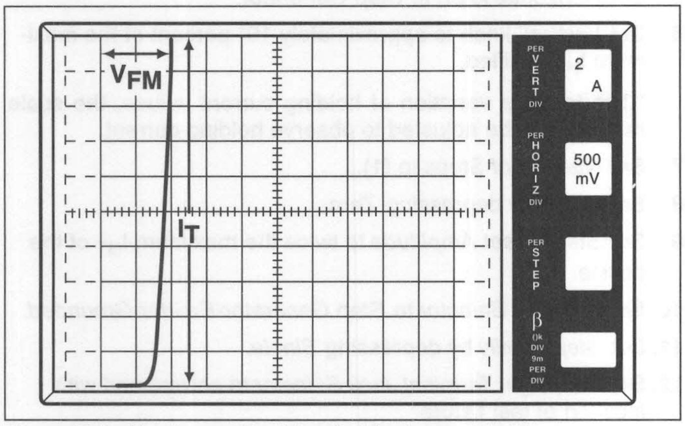


Figure 19.2 V_{FM} is equal to 1.0 volt at I_{PK} is equal to 20

SCRs

SCRs are half-wave unidirectional rectifiers which are turned on when current is supplied to the gate terminal. If the current supplied to the gate is to be in the range of 12-500 microamps, then a sensitive SCR is required; if the gate current is between 1 milliamp and 50 milliamps, then a non-sensitive SCR is required.

To connect the rectifier:

1. Connect *Anode* to *Collector Terminal (C)*.
2. Connect *Cathode* to *Emitter Terminal (E)*.

Note: When sensitive SCRs are being tested, a 1K resistor must be connected between the gate and the cathode, except when testing I_{GT}.

To begin testing, perform the following procedures.

Procedure 1: V_{DRM}, V_{RRM}, I_{DRM}, I_{RRM}

To measure the V_{DRM}, V_{RRM}, I_{DRM}, and I_{RRM} parameter:

1. Set *Collector Voltage Supply Range* to appropriate *Max Peak Volts* for device under test. (Value selected should be equal to or greater than the device's V_{DRM} rating.)
2. Set *Horizontal* knob to sufficient scale to allow viewing of trace at the required voltage level. (The 100V/DIV scale should be used for testing devices having a V_{DRM} value of 600 volts or greater; the 50V/DIV scale for testing parts rated from 300 to 500 volts, and so on.)
3. Set *Mode* to *Leakage*.
4. Set *Polarity* to (+).
5. Set *Power Dissipation* to *0.5 watts*.
6. Set *Terminal Selector* to *Emitter Grounded-Open Base*.
7. Set *Vertical* knob to approximately ten times the maximum leakage current (I_{DRM}, I_{RRM}) specified for the device. (For sensitive SCRs, set to *50 microamps*.)

Note: The CRT screen readout should show 1.0 percent of the maximum leakage current if the vertical scale is divided by one thousand when leakage current mode is used.

Procedure 2: V_{DRM}, I_{DRM}

To measure the V_{DRM} and I_{DRM} parameter:

1. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
2. Set Variable Collector Supply to the rated VDRM of the device and observe the dot on CRT. Read across horizontally from the dot to the vertical current scale. This measured value will be the leakage current. (See Figure 19.3.)

WARNING: Do NOT exceed V_{DRM}/V_{RRM} rating of SCRs, triacs, or Quadracs. These devices can be damaged.

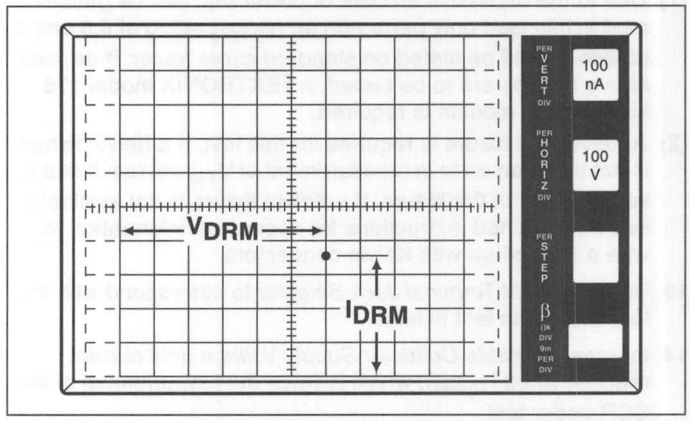


Figure 19.3 I_{DRM} is equal to 350nA at V_{DRM} equal to 600

Procedure 3: V_{RRM}, I_{RRM}

To measure the V_{RRM} and I_{RRM} parameter:

1. Set *Polarity* to (–).
2. Repeat Steps 1 and 2 (V_{DRM}, I_{DRM}) except substitute V_{RRM} value for V_{DRM}. (See Figure 19.4.)

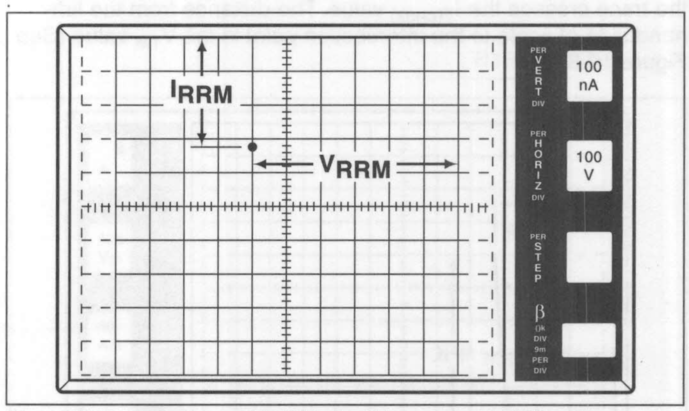


Figure 19.4 I_{RRM} is equal to 340nA at V_{RRM} equal to 600 volts

Procedure 4: V_{TM}

To measure the V_{TM} parameter:

1. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*
2. Set *Polarity* to (+).
3. Set *Step/Offset Amplitude* to twice the maximum I_{GT} rating of the device (to insure the device turns on). For sensitive SCRs, set to 2mA.
4. Set *Max Peak Volts* to *15 volts.*
5. Set *Offset* by depressing *Zero.*

6. Set *Rate* by depressing *Norm.*
7. Set *Step Family* by depressing *Rep* (repetitive).
8. Set *Mode* to *DC.*
9. Set *Horizontal* knob to *0.5V/DIV.*
10. Set *Power Dissipation* to *220 Watts* (*100 Watts* on 577).
11. Set *Number of Steps* to (1).
12. Set *Vertical* knob to a sufficient setting to allow the viewing of 2 times the $I_{T(RMS)}$ rating of the device (I_{Tpeak}) on CRT.

Before continuing with testing, note the following:

(1) Due to the excessive amount of power that can be generated in this test, only parts with an $I_{T(RMS)}$ rating of 6.0 amps or less should be tested on standard curve tracer. If devices above 6 amps are to be tested, a TEKTRONIX model 176 high-current module is required.

(2) A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of V_{TM} will result due to voltage drop in the fixture. If a Kelvin fixture is not available, see the attached instructions for necessary information to wire a test fixture with Kelvin connectors.

13. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
14. Increase *Variable Collector Supply Voltage* until current reaches rated $I_{T(peak)}$, which is twice the $I_{T(RMS)}$ rating of the SCR under test.

WARNING: Limit test time to 15 seconds maximum after the *Variable Collector Supply* has been set to $I_{T(peak)}$. After the *Variable Collector Supply Voltage* has been set to $I_{T(peak)}$, the test time can automatically be shortened by changing *Step Family* from repetitive to single by depressing the *Single* button.

To measure V_{TM}, follow along horizontal scale to the point where the trace crosses the $I_{T(peak)}$ value. The distance from the left-hand side of scale to the intersection point is the V_{TM} value (See Figure 19.5.)

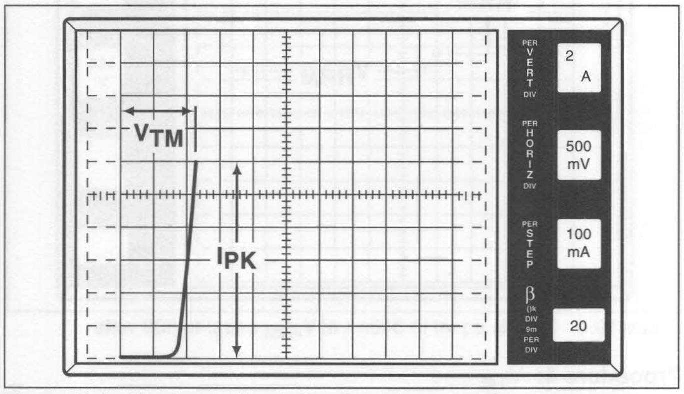


Figure 19.5 V_{TM} is equal to 1.15 volts at $I_{T(pk)}$ equal to 12 amps

Procedure 5: I_H

To measure the I_H parameter:

1. Set *Polarity* to (+).
2. Set *Power Dissipation* to *2.2 watts.*
3. Set *Max Peak Volts* to *75 volts.*
4. Set *Mode* to *DC.*
5. Set *Horizontal* knob to *Step Generator.*
6. Set *Vertical'* knob to approximately 10* percent of the maximum I_H specified.

   *Due to large variation of holding current values, the scale may have to be adjusted to observe holding current.
7. Set *Number of Steps* to (1).
8. Set *Offset* by depressing *Zero.*
9. Set *Step/Offset Amplitude* to twice the maximum I_{GT} of the device.
10. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*
11. Set *Step Family* by depressing *Single.*
12. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
13. Increase *Variable Collector Supply* to maximum position (100).
14. Set *Step Family* by depressing *Single.* (This could possibly cause the dot on CRT to disappear, depending on the vertical scale selected.)
15. Change *Terminal Selector* from *Step Generator-Emitter Grounded* to *Open Base-Emitter Grounded.*
16. Decrease *Variable Collector Supply Voltage* to the point where the line on the CRT changes to a dot. The position of the beginning point of the line, just before the line becomes a dot, represents the holding current value (See Figure 19.6.)

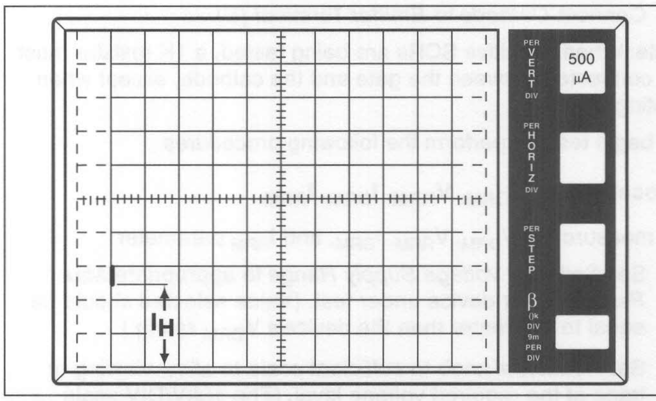


Figure 19.6 IH is 1.2 mA

Procedure 6: I_{GT} and V_{GT}

To measure the I_{GT} and V_{GT} parameter:

1. Set *Polarity* to (+).
2. Set *Number of Steps* to (1).
3. Set *Offset* by depressing *AID.*
4. Set *Offset Multiplier* to 0.0.
5. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*
6. Set *Mode* to *Norm.*
7. Set *Max Peak Volts* to *15 volts.*
8. Set *Power Dissipation* to *2.2 watt.s* (For sensitive SCRs, set at 0.5 watts.)
9. Set *Horizontal* knob to *2V/DIV.*
10. Set *Vertical* knob to *50mA/DIV.*

11. Increase *Variable Collector Supply* until voltage reaches 12 volts on CRT.
12. After 12 volt setting is completed, change *Horizontal* knob to *Step Generator.*

Procedure 7: I_{GT}

To measure the I_{GT} parameter:

1. Set *Step/Offset Amplitude* to 20 percent of maximum rated I_{GT}.

   Note: R_{GK} should be removed when testing I_{GT}.
2. Set *Left-RightTerminal Jack Selector* to correspond with location of the test fixture.
3. Gradually increase *Offset Multiplier* until device reaches the conduction point. (See Figure 19.7.) Measure I_{GT} by following horizontal axis to the point where the vertical line crosses axis. This measured value is I_{GT}.

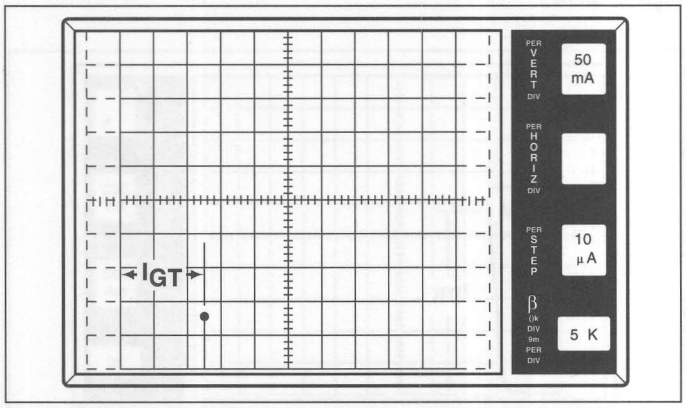


Figure 19.7 I_{GT} is 25µA

Procedure 8: V_{GT}

To measure the V_{GT} parameter:

1. Set *Offset Multiplier* to 0.0.
2. Set *Step Offset Amplitude* to 20 percent rated V_{GT}.
3. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
4. Gradually increase *Offset Multiplier* until device reaches the conduction point (See Figure 19.8.) Measure V_{GT} by following horizontal axis to the point where the vertical line crosses axis. This measured value is V_{GT}.

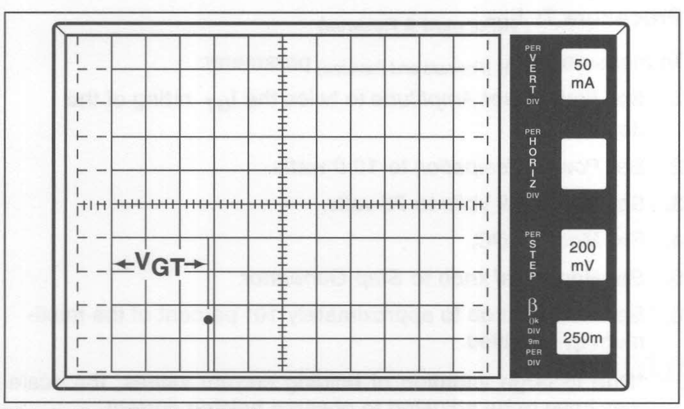


Figure 19.8 V_{GT} is 580mV

TRIACS

Triacs are full-wave bidirectional AC switches which are turned on when current is supplied to the gate terminal of the device. If gate control in all four (4) quadrants is required, then a sensitive gate triac is needed, whereas a standard triac can be used if gate control is only required in Quadrants I-III.

To connect the triac:

1. Connect the *Gate* to the *Base Terminal* (B).
2. Connect *MT1* to the *Emitter Terminal* (E).
3. Connect *MT2* to the *Collector Terminal* (C).

To begin testing, perform the following procedures.

Procedure 1: $(+)V_{DRM}$, $(+)I_{DRM}$, $(-)V_{DRM}$, $(-)I_{DRM}$

Note: The (+) and (-) symbols are used to designate the polarity MT2 with reference to MT1.

To measure the $(+)V_{DRM}$, $(+)I_{DRM}$, $(-)V_{DRM}$, and $(-)I_{DRM}$ parameter:

1. Set *Collector Voltage Supply Range* to appropriate *Max Peak Volts* for device under test. (Value selected should be equal to the device's V_{DRM} rating.)

WARNING: Do NOT exceed V_{DRM}/V_{RRM} rating of SCRs, triacs, or Quadracs. These devices can be damaged.

2. Set *Horizontal* knob to sufficient scale to allow viewing of trace at the required voltage level. (The 100V/DIV scale should be used for testing devices having a V_{DRM} rating of 600 volts or greater; the 50V/DIV scale for testing parts rated from 30 to 500 volts, and so on.)
3. Set *Mode* to *Leakage.*
4. Set *Polarity* to (+).
5. Set *Power Dissipation* to *0.5 watts.*
6. Set *Terminal Selector* to *Emitter Grounded-Open Base.*
7. Set *Vertical* knob to ten times the maximum leakage current (I_{DRM}) specified for the device.

   Note: The CRT screen readout should show 1.0 percent of the maximum leakage current. The vertical scale is divided by one thousand when leakage mode is used.

Procedure 2: $(+)V_{DRM}$, $(+)I_{DRM}$

To measure the $(+)V_{DRM}$ and $(+)I_{DRM}$ parameter:

1. Set *Left-Right Terminal Jack Selector* to correspond with location of the test fixture.
2. Increase *Variable Collector Supply Voltage* to the rated V_{DRM} of the device and observe the dot on the CRT. Read across horizontally from the dot to the vertical current scale. This measured value will be the leakage current. (See Figure 19.9.)

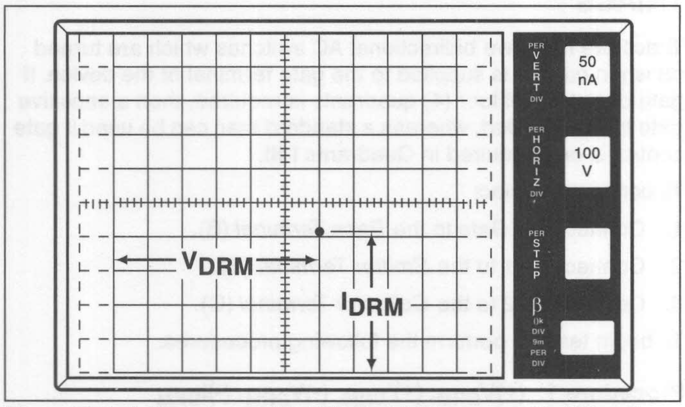


Figure 19.9 (+)I_{DRM} is equal to 205nA at (+)V_{DRM} equal to 600 volts

Procedure 3: (-)V_{DRM}, (-)I_{DRM}

To measure the (-)V_{DRM} and (-)I_{DRM} parameter:

1. Set *Polarity* to (-).
2. Repeat Procedures 1 and 2. (Read measurements from upper right corner of the screen.)

Procedure 4: V_{TM} (Forward and Reverse)

To measure the $V_{TM \text{ (Forward and Reverse)}}$ parameter:

1. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*
2. Set *Step/Offset Amplitude* to twice the maximum I_{GT} rating of the device (to insure the device turns on).
3. Set *Collector Voltage Supply Range* to *15 Max Peak volts.*
4. Set *Offset* by depressing *"Zero".*
5. Set *Rate* by depressing *"Norm".*
6. Set *Step Family* by depressing *Rep* (Repetitive).
7. Set *Mode* to *Norm.*
8. Set *Horizontal* knob to *0.5V/DIV.*
9. Set *Power Dissipation* to *220 watts* (*100 watts* on 577).
10. Set *Number of Steps* to (1).
11. Set Set/Offset Polarity to non-inverted (button extended; on 577 button depressed).
12. Set *Vertical* knob to a sufficient setting to allow the viewing of 1.4 times the $I_{T(RMS)}$ rating of the device [$I_{T(peak)}$ on CRT].

Note the following:

- Due to the excessive amount of power that can be generated in this test, only parts with an IT (RMS) rating of 8.0 amps or less should be tested on standard curve tracer. If devices above 8 amps are to be tested, a TEKTRONIX model 176 high-current module is required.
- A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of VTM will result due to voltage drop in fixture. If a Kelvin fixture is not available, see the attached instructions for necessary information to wire a test fixture with Kelvin connections.

Procedure 5: $V_{TM \text{ (Forward)}}$

To measure the $V_{TM \text{ (Forward)}}$ parameter:

1. Set *Polarity* to (+).
2. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
3. Increase *Variable Collector Supply Voltage* until current reaches rated $I_{T(peak)}$, which is 1.4 times $I_{T(RMS)}$ rating of the triac under test.

WARNING: Limit test time to 15 seconds maximum. After the *Variable Collector Supply Voltage* has been set to $I_{T(peak)}$, the test time can automatically be set to a short test time by changing *Step Family* from repetitive to single by depressing the *Single* button.

To measure V_{TM}, follow along horizontal scale to the point where the trace crosses the $I_{T(peak)}$ value. The distance from the left-hand side of scale to the crossing point is the V_{TM} value. (See Figure 19.10.)

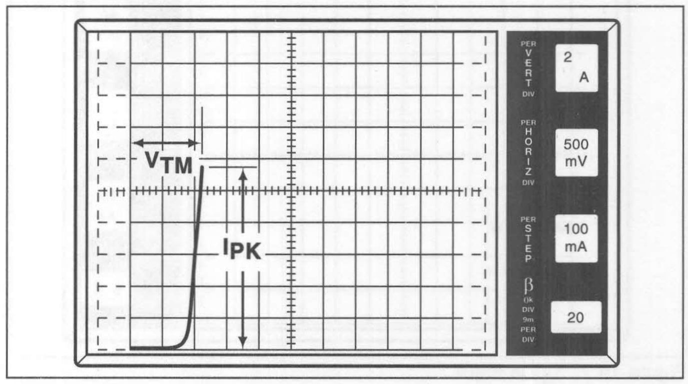


Figure 19.10 $V_{TM \text{ (forward)}}$ is equal to 1.1 volts at IPK equal to 11.3 amps (8 amps [RMS])

Procedure 6: $V_{TM \text{ (Reverse)}}$

To measure the $V_{TM \text{ (Reverse)}}$ parameter:

1. Set *Polarity* to (-).
2. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
3. Increase *Variable Collector Supply Voltage* until current reaches rated $I_{T(peak)}$.
4. Measure $V_{TM(Reverse)}$ per above.

Procedure 7: $I_{H(Forward \& Reverse)}$

To measure the $I_{H \text{ (Forward and Reverse)}}$ parameter:

1. Set *Step/Offset Amplitude* to twice the I_{GT} rating of the device.
2. Set *Power Dissipation* to *10.0 watts.*
3. Set *Max Peak Volts* to *75 volts.*
4. Set *Mode* to *DC.*
5. Set *Horizontal* knob to *Step Generator.*
6. Set *Vertical* knob to approximately 10* percent of the maximum I_H specified.

   *Due to large variation of holding current values, the scale may have to be adjusted to observe holding current.

7. Set *Number of Steps* to (1).
8. Set *Step Offset Polarity* to non-inverted (button extended, on 577 button depressed).
9. Set *Offset* by depressing *Zero.*
10. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*

Procedure 8: $I_{H(Forward)}$

To measure the $I_{H\ (Forward)}$ parameter:

1. Set *Polarity* to (+)
2. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
3. Increase *Variable Collector Supply Voltage* to maximum position (100).
4. Set *Step Family* by depressing *Single.*

   This could possibly cause the dot on the CRT to disappear, depending on the vertical scale selected).
5. Decrease *Variable Collector Supply Voltage* to the point where the line on the CRT changes to a dot. The position of the beginning point of the line, just before the line becomes a dot, represents the holding current value (See Figure 19.11.)

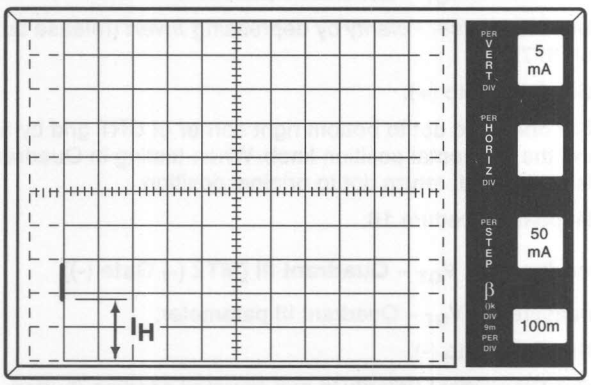


Figure 19.11 $I_{H\ (Forward)}$ is 8.2mA

Procedure 9: $I_{H(Reverse)}$

To measure the $I_{H\ (Reverse)}$ parameterg:

1. Set *Polarity* to (-).
2. Repeat Procedure 7 measuring $I_{H(Reverse)}$. (Read measurements from upper-right corner of the screen.)

Procedure 10: I_{GT}

To measure the I_{GT} parameter:

1. Set *Polarity* to (+).
2. Set *Number of Steps* to (1).
3. Set *Offset* by depressing *Aid.*

   (On 577, also set *Zero* button to *Offset.* Button is extended.)
4. Set *Offset Multiplier* to *0.0.*
5. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*
6. Set *Mode* to *Norm.*
7. Set *Max Peak Volts* to *15 volts.*
8. Set *Power Dissipation* to *10.0 watts.*
9. Set *Step Family* by depressing *Single.*
10. Set *Horizontal* knob to *2V/DIV.*
11. Set *Vertical* knob to *50mA/DIV.*
12. Set *Step/Offset Polarity* to non-inverted position (button extended, on 577 button depressed).
13. Set *Variable Collector Supply Voltage* until voltage reaches 12 volts on CRT.
14. After 12 volt setting is completed, change *Horizontal* knob to *Step Generator.*

Procedure 11: I_{GT} – Quadrant I [MT2 (+) Gate (+)]

To measure the I_{GT} – Quadrant I parameter:

1. Set *Step/Offset Amplitude* to approximately 10 percent of rated I_{GT}.
2. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
3. Gradually increase *Offset Multiplier* until device reaches conduction point. (See Figure 19.12.) Measure I_{GT} by following horizontal axis to the point where the vertical line passes through the axis. This measured value will be I_{GT}.

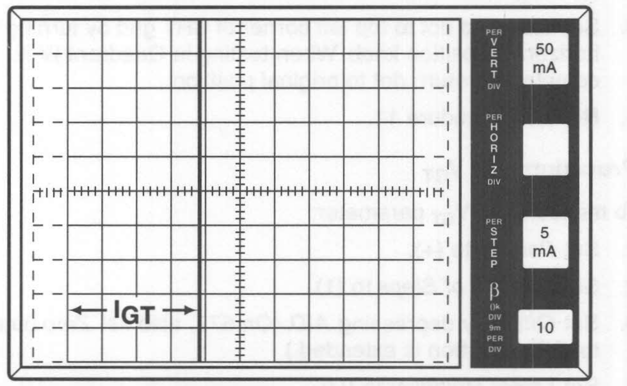


Figure 19.12 I_{GT} in QI is 18.8mA

Procedure 12: I_{GT} – Quadrant II [MT2 (+) Gate (-)]

To measure the I_{GT} – Quadrant II parameter:

1. Set *Step/Offside Polarity* by depressing Invert (release button on 577).
2. Set *Polarity* to (+).
3. Set observed dot to bottom right corner of CRT grid by turning the horizontal position knob. When testing in Quadrant II is completed, return dot to original position.
4. Repeat Procedure 11.

Procedure 13: I_{GT} – Quadrant III [MT2 (-) Gate (-)]

To measure the I_{GT} – Quadrant III parameter:

1. Set *Polarity* to (-).
2. Set *Step/Offset Polarity* to non-inverted position (button extended, on 577 button depressed).
3. Repeat Procedure 11. (See Figure 19.13.)

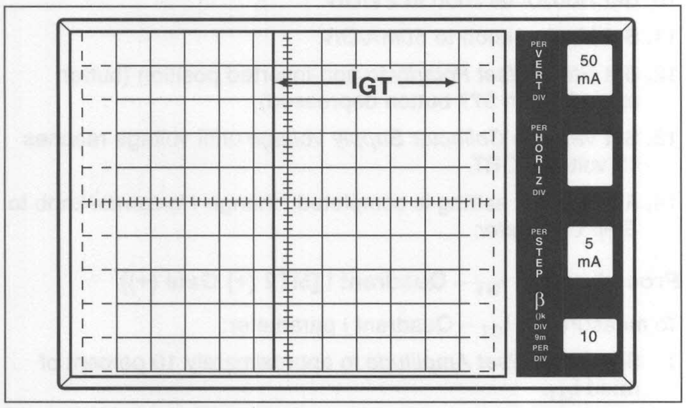


Figure 19.13 I_{GT} in QIII is 27mA

Procedure 14: I_{GT} – Quadrant IV [MT2 (-) Gate (+)]

To measure the I_{GT} – Quadrant IV parameter:

1. Set *Polarity* to (-).
2. Set *Step/Offset Polarity* by depressing *Invert* (release button on 577).
3. Set observed dot to top left corner of CRT grid by turning the horizontal position knob. When testing in Quadrant IV is completed, return dot to original position.
4. Repeat Procedure 11.

Procedure 15: V_{GT}

To measure the V_{GT} parameter:

1. Set *Polarity* to (+).
2. Set *Number of Steps* to (1).
3. Set *Offset* by depressing *AID.* (On 577, also set *Zero* button to *Offset.* Button is extended.)
4. Set *Offset Multiplier* to *0.0.*
5. Set *Terminal Selector* to *Step Generator-Emitter Grounded.*
6. Set *Mode* to *Norm.*
7. Set *Max Peak Volts* to *15 volts.*
8. Set *Power Dissipation* to *10 watts.*
9. Set *Step Family* by depressing *Single.*
10. Set *Horizontal* knob to *2 volts/DIV.*
11. Set *Step/Offset Polarity* to non-inverted position (button extended, on 577 button depressed).
12. Set *Current Limit* to 500mA (not available on 577).
13. Increase *Variable Collector Supply Voltage* until voltage reaches 12 volts on CRT.
14. After 12 volt setting is completed, change *Horizontal* knob to *Step Generator.*

Procedure 16: V_{GT} – Quadrant I [MT2 (+) Gate (+)]

To measure the V_{GT} – Quadrant I parameter:

1. Set *Step/Offset Amplitude* to 20 percent of rated V_{GT}.
2. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.
3. Gradually increase *Offset Multiplier* until device reaches conduction point (See Figure 19.14.) Measure V_{GT} by following horizontal axis to the point where the vertical line passes through the axis. This measured value will be V_{GT}.

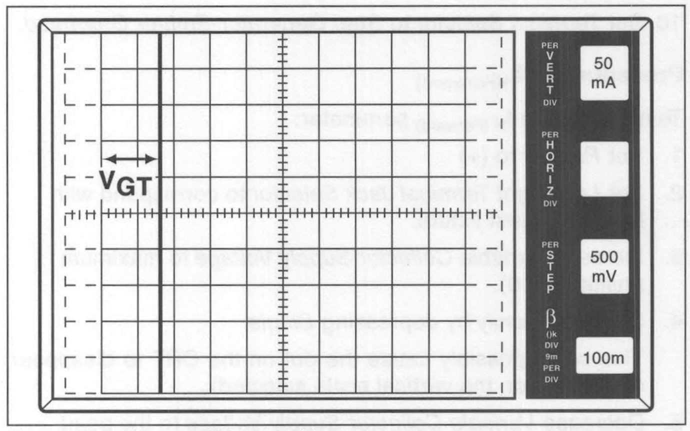


Figure 19.14 V_{GT} in QI is 780mV

Procedure 17: V_{GT} – Quadrant II [MT2 (+) Gate (-)]

To measure the V_{GT} – Quadrant II parameter:

1. Set *Step/Offset Polarity* by depressing *Invert* (release button on 577).
2. Set *Polarity* to (+).
3. Set observed dot to bottom right corner of CRT grid by turning the horizontal position knob. When testing in Quadrant II is completed, return dot to original position.
4. Repeat Procedure 16.

Procedure 18: V_{GT} – Quadrant III [MT2 (-) Gate (-)]

To measure the V_{GT} – Quadrant III parameter:

1. Set *Polarity* to (-).
2. Set *Step/Offset Polarity* to non-inverted position (button extended, on 577 button depressed).
3. Repeat Procedure 16. (See Figure 19.15.)

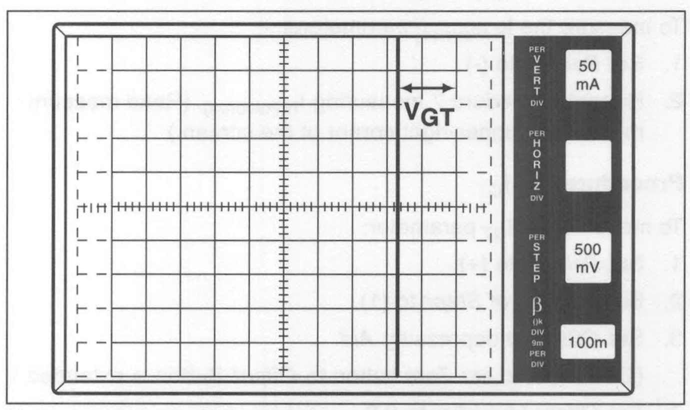


Figure 19.15 V_{GT} in QIII is 820mV

Procedure 19: V_{GT} – Quadrant IV [MT2 (-) Gate (+)]

To measure the V_{GT} – Quadrant IV parameter:

1. Set *Polarity* to (-).
2. Set *Step/Offset Polarity* by depressing *Invert* (release button on 577).
3. Set observed dot to top left corner of CRT grid by turning the horizontal position knob. When testing is complete in Quadrant IV, return dot to original position.
4. Repeat Procedure 16.

QUADRACS

QUADRACs are simply triacs with an internally-mounted diac. As with triacs, QUADRACs are bidirectional AC switches which are gate controlled for either polarity of main terminal voltage.

To connect the QUADRAC:

1. Connect *Trigger* to *Base Terminal* (B)
2. Connect *MT1* to *Emitter Terminal* (E)
3. Connect *MT2* to *Collector Terminal* (C)

To begin testing, perform the following procedures.

Procedure 1: (+)V_{DRM}, (+)I_{DRM}, (-)V_{DRM}, (-)I_{DRM}

Note: the (+) and (-) symbols are used to designate the polarity of MT2 with reference to MT1.

To measure the (+)V_{DRM}, (+)I_{DRM}, (-)V_{DRM}, and (-)I_{DRM} parameter:

1. Set *Collector Voltage Supply Range* to appropriate *Max Peak Volts* for device under test. (Value selected should be equal to or greater than the device's V_{DRM} rating).
2. Set *Horizontal* knob to sufficient scale to allow viewing of trace at the required voltage level. (The 100V/DIV scale should be used for testing devices having a V_{DRM} rating of 600 volts or greater; the 50V/DIV scale for testing parts rated from 300 to 500 volts, and so forth).
3. Set *Mode* to *Leakage.*
4. Set *Polarity* to (+).
5. Set *Power Dissipation* to *0.5 watts.*
6. Set *Terminal Selector* to *Emitter Grounded-Open Base.*
7. Set *Vertical* knob to ten times the maximum leakage current (I_{DRM}) specified for the device.

   Note: The CRT readout should show 1.0 percent of the maximum leakage current. The vertical scale is divided by one thousand when the leakage mode is used.

Procedure 2: (+)V_{DRM} and (+)I_{DRM}

To measure the (+)V_{DRM} and (+)I_{DRM} parameter:

1. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
2. Increase *Variable Collector Supply Voltage* to the rated V_{DRM} of the device and observe the dot on the CRT. (Read across horizontally from the dot to the vertical current scale.) This measured value will be the leakage current. (See Figure 19.16.)

WARNING: Do NOT exceed V_{DRM}/V_{RRM} rating of SCRs, triacs, or Quadracs. These devices can be damaged.

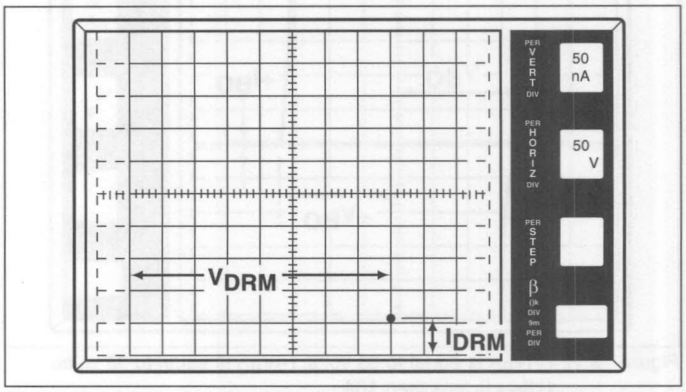


Figure 19.16 (+)I_{DRM} is equal to 51nA at (+)V_{DRM} equal to 400 volts

Procedure 3: (-)V_{DRM} and (-)I_{DRM}

To measure the (-)V_{DRM} and (-)I_{DRM} parameter:

1. Set *Polarity* to (-).
2. Repeat Procedures 1 and 2. (Read measurements from upper right corner of screen).

Procedure 4: V_{BO}, I_{BO}, ΔV_{BO} (QUADRAC Trigger Diac or Discrete Diac)

To connect the QUADRAC:

1. Connect *MT1* to *Emitter Terminal* (E).
2. Connect *MT2* to *Collector Terminal* (C).
3. Connect *Trigger Terminal* to *MT2 Terminal* through a 10 Ohm resistor.

To measure the V_{BO}, I_{BO} , and ΔV_{BO} parameter:

1. Set *Collector Voltage Supply Range* to *75 Max Peak volts.*
2. Set *Horizontal* knob to *10 volts/DIV.*
3. Set *Vertical* knob to *50 microamps/DIV.*
4. Set *Polarity* to *AC.*
5. Set *Mode* to *Norm.*
6. Set *Power Dissipation* to *0.1 watts.*
7. Set *Terminal Selector* to *Emitter Grounded-Open Base.*

Procedure 5: V_{BO} (Positive and Negative)

To measure the V_{BO} (Positive and Negative) parameter:

1. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
2. Increase *Variable Collector Supply Voltage* until breakover occurs. (See Figure 19.18.) The voltage at which current begins to flow and the voltage does not increase is the V_{BO} value.

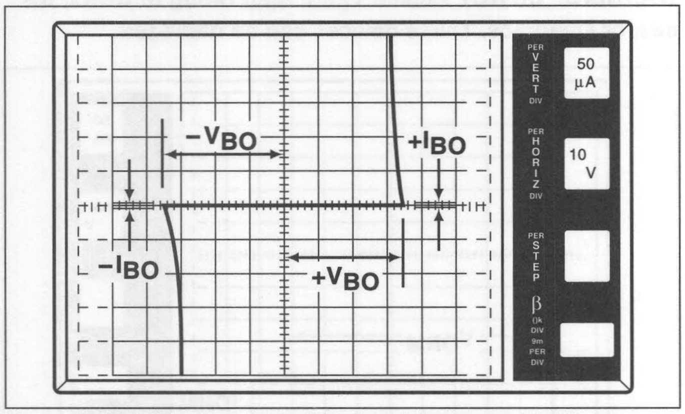


Figure 19.17 (+)V_{BO} is equal to 35 volts; (-)V_{BO} is equal to 36 volts; (±)I_{BO} is less than 10A

Procedure 6: I_{BO} (Positive and Negative)

To measure the I_{BO} (Positive and Negative) parameter, at the V_{BO} point, measure the amount of device current just before the device reaches the breakover point. The measured current at this point is the I_{BO} value.

Note: If I_{BO} is less than 10 microamps, the current cannot readily be seen on curve tracer.

Procedure 7: ΔV_{BO} (Voltage Breakover Symmetry)

To measure the ΔV_{BO} (Voltage Breakover Symmetry) parameter:

1. Measure positive and negative V_{BO} values per Procedure 5.
2. Subtract the absolute value of V_{BO} (-) from V_{BO} (+).

   The absolute value of the result is:

   ΔV_{BO}: $\Delta V_{BO} = [\ |+V_{BO}| - |-V_{BO}|\ ]$

Procedure 8: V_{TM} (Forward and Reverse)

To test VTM, the quadrac must be connected the same as when testing V_{BO}, I_{BO}, and ΔV_{BO}.

To connect the QUADRAC:

1. Connect *MT1* to *Emitter Terminal* (E).
2. Connect *MT2* to *Collector Terminal* (C).
3. Connect *Trigger Terminal* to *MT2 Terminal* through a 10 Ohm resistor.

Note the following:

- Due to the excessive amount of power that can be generated in this test, only parts with an $I_{T(RMS)}$ rating of 8.0 amps or less should be tested on standard curve tracer. If devices above 8 amps are to be tested, a "TEKTRONIX" model 176 high-current module is required.
- A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of V_{TM} will result due to voltage drop in fixture. If a Kelvin fixture is not available, see the attached instructions for necessary information to wire a test fixture with Kelvin connections.

To measure the V_{TM} (Forward and Reverse) parameter:

1. Set *Terminal Selector* to *Emitter Grounded-Open Base.*
2. Set *Max Peak Volts* to *75 volts.*
3. Set *Mode* to *Norm.*
4. Set *Horizontal* knob to *0.5 V/DIV.*
5. Set *Power Dissipation* to *220 watts* (*100 watts* on a 577).
6. Set *Vertical* knob to a sufficient setting to allow the viewing of 1.4 times the $I_{T(RMS)}$ rating of the device $I_{T(peak)}$ on the CRT.

Procedure 9: $V_{TM(Forward)}$

To measure the $V_{TM\ (Forward)}$ parameter:

1. Set *Polarity* to (+).
2. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
3. Increase *Variable Collector Supply Voltage* until current reaches rated $I_{T(peak)}$, which is 1.4 times the $I_{T(RMS)}$ rating of the triac under test.

WARNING: Limit test time to 15 seconds maximum.

4. To measure V_{TM}, follow along horizontal scale to the point where the trace crosses the $I_{T(peak)}$ value. This horizontal distance is the V_{TM} value. (See Figure 19.18.)

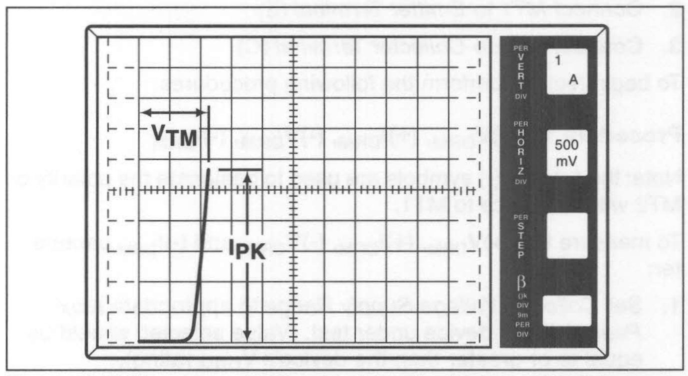


Figure 19.18 $V_{TM\ (Forward)}$ is equal to 1.1 volts at Ipk equal to 5.6 amps

Procedure 10: $V_{TM(Reverse)}$

To measure the $V_{TM\ (Reverse)}$ parameter:

1. Set *Polarity* to (-).
2. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
3. Increase *Variable Collector Supply Voltage* until current reaches rated $I_{T(peak)}$.
4. Measure $V_{TM(Reverse)}$ the same as in Procedure 8. (Read measurements from upper right corner of screen).

Procedure 11: $I_{H(Forward\ and\ Reverse)}$

For these steps, it is again necessary to connect the *Trigger* to *MT2* through a 10 Ohm resistor. The other connections remain the same.

To measure the $I_{H\ (Forward\ and\ Reverse)}$ parameter:

1. Set *Power Dissipation* to *50 watts.*
2. Set *Max Peak Volts* to *75 volts.*
3. Set *Mode* to *DC.*
4. Set *Horizontal* knob to *5V/DIV.*

5. Set *Vertical* knob to approximately 10* percent of the maximum I_H specified.

   *Due to large variations of holding current values, the scale may have to be adjusted to observe holding current.

6. Set *Terminal Selector* to *Emitter Grounded-Open Base.*

Procedure 12: $I_{H(Forward)}$

To measure the $I_{H\ (Forward)}$ parameter:

1. Set *Polarity* to (+).
2. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
3. Increase *Variable Collector Supply Voltage* to maximum position (100).

   Note: Depending on the vertical scale being used, the dot may disappear completely from the screen.

4. Decrease *Variable Collector Supply Voltage* to the point where the line on the CRT changes to a dot. The position of the beginning point of the line, just before the line changes to a dot, represents the I_H value (See Figure 19.19.)

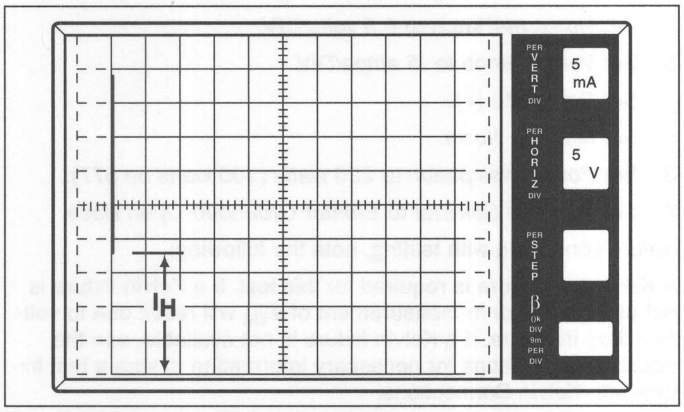


Figure 19.19 $I_{H\ (Forward)}$ is equal to 18mA

Procedure 13: $I_{H(Reverse)}$

To measure the $I_{H\ (Reverse)}$ parameter:

1. Set *Polarity* to (-).
2. Continue testing per Procedure 12 for measuring $I_{H\ (Reverse)}$.

SIDACS

The Sidac is a bidirectional voltage-triggered switch. Upon application of a voltage exceeding the sidac breakover voltage point, the sidac switches on through a negative resistance region (similar to a diac) to a low on-state voltage. Conduction continues until current is interrupted or drops below minimum required holding current.

To connect the Sidac:

1. Connect *MT1* to the *Emitter Terminal* (E).
2. Connect *MT2* to the *Collector Terminal* (C).

To begin testing, perform the following procedures.

Procedure 1: (+) V_{DRM}, (+)I_{DRM}, (-)V_{DRM}, (-)I_{DRM}

Note: the (+) and (-) symbols are used to designate the polarity of MT2 with reference to MT1.

To measure the (+)V_{DRM}, (+)I_{DRM}, (-)V_{DRM}, and (-)I_{DRM} parameter:

1. Set *Collector Voltage Supply Range* to *1500 Max Peak volts.*
2. Set *Horizontal* knob to *50 volts/DIV.*
3. Set *Mode* to *Leakage.*
4. Set *Polarity* to (+).
5. Set *Power Dissipation* to *2.2 watts.*
6. Set *Terminal Selector* to *Emitter Grounded-Open Base.*
7. Set *Vertical* knob to *50 microamps/DIV.* (Due to leakage mode, the CRT readout will show 50 nA.)

Procedure 2: (+)V_{DRM} and (+)I_{DRM}

To measure the (+)V_{DRM} and (+)I_{DRM} parameter:

1. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
2. Increase *Variable Collector Supply Voltage* to the rated V_{DRM} of the device and observe the dot on the CRT. Read across horizontally from the dot to the vertical current scale. This measured value will be the leakage current. (See Figure 19.20.)

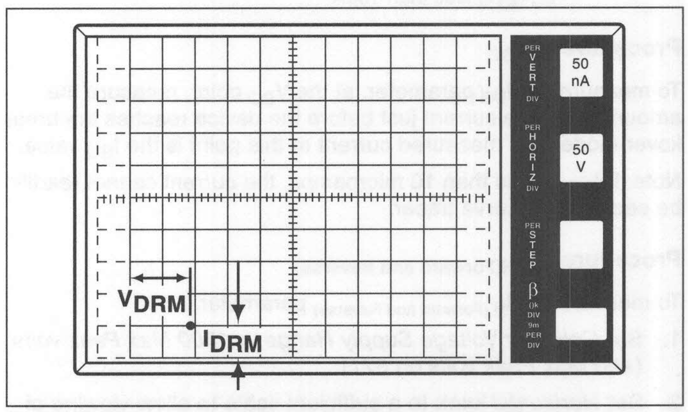


Figure 19.20 I_{DRM} is equal to 50nA at V_{DRM} equal to 90 volts

Procedure 3: (-) V_{DRM} and (-) I_{DRM}

To measure the (-)V_{DRM} and (-)I_{DRM} parameter:

1. Set *Polarity* to (-).
2. Repeat Procedures 1 and 2. (Read measurements from upper right corner of the screen).

Procedure 4: V_{BO} and I_{BO}

To measure the V_{BO} and I_{BO} parameter:

1. Set *Collector Voltage Supply Range* to *1500 Max Peak volts.*
2. Set *Horizontal* knob to a sufficient scale to allow viewing of trace at the required voltage level (50 volts/DIV for 95-215 volt V_{BO} range devices and 100 volts/DIV for devices having $V_{BO\geq}$ 15 volts).
3. Set *Vertical* knob to *50 microamps/DIV.*
4. Set *Polarity* to *AC.*
5. Set *Mode* to *Norm.*
6. Set *Power Dissipation* to *10 watts.*

7. Set *Terminal Selector* to *Emitter Grounded-Open Base.*
8. Set *Left-Right Terminal Jack Selector* to correspond with location of test fixture.

Procedure 5: V_{BO}

To measure the V_{BO} parameter, increase *Variable Collector Supply Voltage* until breakover occurs. (See Figure 19.21.) The voltage at which current begins to flow and voltage on CRT does not increase is the V_{BO} value.

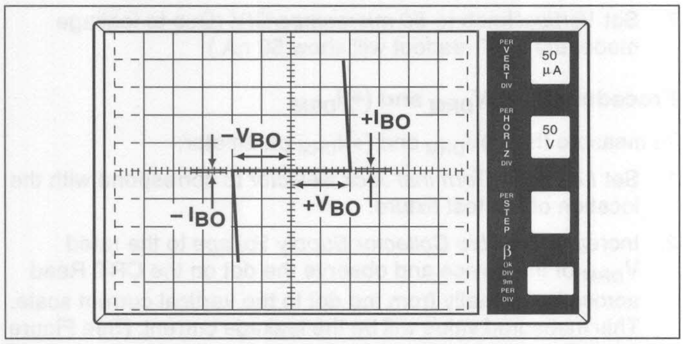


Figure 19.21 (+)V_{BO} is equal to 100 volts; (-)V_{BO} is equal to 100 volts; (±)I_{BO} is less than 10µA

Procedure 6: I_{BO}

To measure the I_{BO} parameter, at the V_{BO} point, measure the amount of device current just before the device reaches the breakover mode. The measured current at this point is the I_{BO} value.

Note: If I_{BO} is less than 10 microamps, the current cannot readily be seen on the curve tracer.

Procedure 7: $I_{H(\text{Forward and Reverse})}$

To measure the $I_{H\ (\text{Forward and Reverse})}$ parameter:

1. Set *Collector Voltage Supply Range* to *1500 Max Peak volts* (*400 Max Peak volts* on 577).
2. Set *Horizontal* knob to a sufficient scale to allow viewing of trace at the required voltage level (50 volts/DIV for devices with V_{BO} range from 95-215 volts, and 100 volts/DIV for devices having VBO≥ 215 volts).
3. Set *Vertical* knob to 20 percent of maximum holding current specified.
4. Set *Polarity* to *AC.*
5. Set *Mode* to *Norm.*
6. Set *Power Dissipation* to *220 watts* (*100 watts* on 577).
7. Set *Terminal Selector* to *Emitter Grounded-Open Base.*
8. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.

WARNING: Limit test time to 15 seconds maximum.

9. Increase *Variable Collector Supply Voltage* until device breaksover and turns on. (See Figure 19.22.)

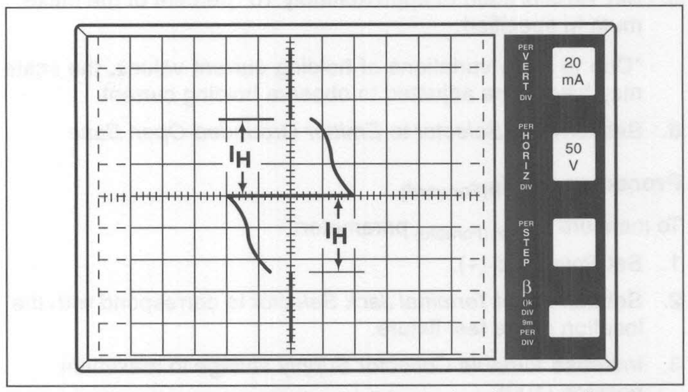


Figure 19.22 I_H is equal to 48mA in both forward and reverse directions

I_H is the vertical distance between the center horizontal axis and the beginning of the line located on center vertical axis.

Procedure 8: $V_{TM(\text{Forward and Reverse})}$

To measure the $V_{TM\ (\text{Forward and Reverse})}$ parameter:

1. Set *Collector Voltage Supply Range* to *350 Max Peak volts.*
2. Set *Horizontal* knob to *0.5 volts/DIV.*
3. Set *Vertical* knob to *.5 amps/DIV.*
4. Set *Polarity* to (+).
5. Set *Mode* to *Norm.*
6. Set *Power Dissipation* to *220 watts* (*100 watts* on 577).
7. Set *Terminal Selector* to *Emitter Grounded-Open Base.*

Before continuing with testing, note the following:

A Kelvin test fixture is required for this test. If a Kelvin fixture is not used, an error in measurement of V_{TM} will result due to voltage drop in fixture. If a Kelvin fixture is not available, see the attached instructions for necessary information to wire a test fixture with Kelvin Connections.

To continue testing, perform the following procedures.

Procedure 9: $V_{TM(\text{Forward})}$

To measure the $V_{TM\ (\text{Forward})}$ parameter:

1. Set *"Left-Right Terminal Jack Selector"* to correspond with the location of the test fixture.
2. Increase *"Variable Collector Supply Voltage"* until current reaches rated $I_{T(peak)}$, which is 1.4 times the $I_{T(RMS)}$ rating of the sidac.

WARNING: Limit test time to 15 seconds.

3. To measure V_{TM}, follow along horizontal scale to the point where the trace crosses the $I_{T(peak)}$ value. This horizontal distance is the V_{TM} value. (See Figure 19.23.)

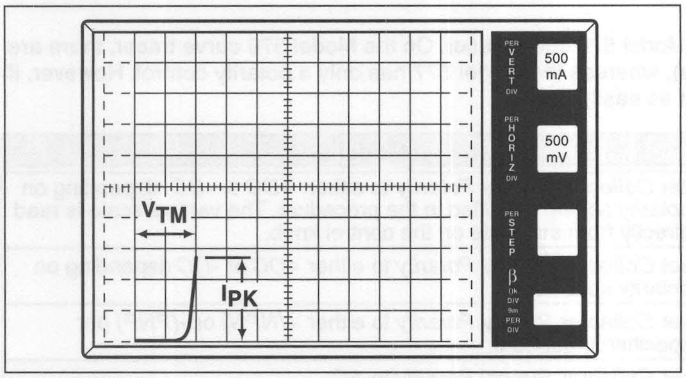


Figure 19.23 $V_{TM\ (Forward)}$ is equal to 950mV at I_{PK} equal to 1.4 amps

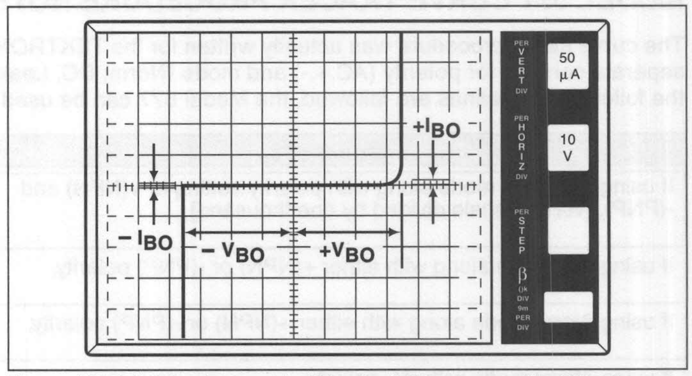


Figure 19.24 (+)V_{BO} is equal to 35 volts; (-)V_{BO} is equal to 36 volts; (±)I_{BO} is less than 15µA; (-)I_{BO} is less than 10µA and cannot easily be read

Procedure 10: $V_{TM(Reverse)}$

To measure the $V_{TM\ (Reverse)}$ parameter:

1. Set *Polarity* to (-).
2. Repeat Procedure 8 to measure $V_{TM(Reverse)}$.

DIACS

Diacs are voltage breakdown switches used to "trigger-on" triacs and non-sensitive SCRs in phase control circuits.

Note: Diacs are bi-directional devices and can be connected in either direction.

To connect the Diac:

1. Connect one side of the diac to the *Collector Terminal* (C).
2. Connect other side of the diac to the *Emitter Terminal* (E).

To begin testing, perform the following procedures.

Procedure 1: Curve Tracer Setup

To set the curve tracer and begin testing:

1. Set *Collector Voltage Supply Range* to *75 Max Peak volts.*
2. Set *Horizontal* knob to sufficient scale to allow viewing of trace at the required voltage level (10 to 20 volts/DIV depending on device being tested).
3. Set *Vertical* knob to *50 microamps/DIV.*
4. Set *Polarity* to *AC.*
5. Set *Mode* to *Norm.*
6. Set *Power Dissipation* to *0.5 watts.*
7. Set *Terminal Selector* to *Emitter Grounded-Open Base.*

Procedure 2: V_{BO}

To measure the V_{BO} parameter:

1. Set *Left-Right Terminal Jack Selector* to correspond with the location of the test fixture.
2. Increase *Variable Collector Supply Voltage* until breakover occurs. (See Figure 19.24.) The voltage at which current begins to flow and voltage does not increase is the V_{BO} value.

Procedure 3: I_{BO}

To measure the I_{BO} parameter, at the V_{BO} point, measure the amount of device current just before the device reaches the breakover mode. The measured current at this point is the I_{BO} value.

Note: If I_{BO} is less than 10 microamps, the current cannot readily be seen on the curve tracer.

Procedure 4: ΔV_{BO} (Voltage Breakover Symmetry)

To measure the $\Delta V_{BO\ (Voltage\ Breakover\ Symmetry)}$ parameter:

1. Measure positive and negative values of V_{BO} per above.
2. Subtract the absolute value of V_{BO} (-) from V_{BO}(+).

   The absolute value of the result is:

   ΔV_{BO}: ΔV_{BO}=[I +VBO I - I -VBOI]

MODEL 577 CURVE TRACER PROCEDURE NOTES

The curve tracer procedure was actually written for the TEKTRONIX Model 576 curve tracer. On the Model 576 curve tracer, there are separate controls for polarity (AC,+,-) and mode (Norm, DC, Leakage), whereas the Model 577 has only a polarity control. However, if the following guidelines are followed, the Model 577 can be used just as easily.

Model 576	Model 577
If using *Leakage* mode along with polarity setting of +(NPN) and -(PNP), [vertical scale divided by one thousand],	set *Collector Supply Polarity* to either *+DC* or *-DC*, depending on polarity setting specified in the procedure. The vertical scale is read directly from the scale on the control knob.
If using *DC* mode along with either +(NPN) or -(PNP) polarity,	set *Collector Supply Polarity* to either *+DC* or *-DC* depending on polarity specified.
If using *Norm* mode along with either +(NPN) or -(PNP) polarity,	set *Collector Supply Polarity* to either *+(NPN)* or *-(PNP)* per specified procedure.
If using *Norm* mode with *AC* polarity,	set *Collector Supply Polarity* to *AC*.

Another minor difference between the two models is in setting the *Step/Offset Polarity*. The polarity is inverted when the button is depressed on the Model 576 curve tracer. The Model 577 is opposite — the *Step/Offset Polarity* is "inverted" when the button is extended and "Normal" when the button is depressed. The *Step/Offset Polarity* is used only when measuring I_{GT} and V_{GT} of triacs and QUADRACs in Quadrants I-IV.

Also, the *Variable Collector Supply Voltage Range* and *Power Dissipation* controls have different scales between the two different models, as shown in the following table:

Model 576	Model 577
If power dissipation is 0.1 watts,	set at 0.15 watts.
If power dissipation is 0.5 watts,	set at 0.6 watts.
If power dissipation is 2.2 watts,	set at 2.3 watts.
If power dissipation is 10 watts,	set at 9 watts.
If power dissipation is 50 watts,	set at 30 watts.
If power dissipation is 220 watts,	set at 100 watts.

Although the maximum power setting on the Model 576 curve tracer is 220 watts, versus 100 watts for the Model 577, the maximum collector current available is approximately the same. This is due to the minimum voltage range on the Model 577 being 6.5 volts vs 15 volts for the Model 576 curve tracer. The following table shows the correct *Collector Voltage Supply Range* settings:

Model 576	Model 577
If voltage range is 15 volts,	set at either 6.5 volts or 25 volts, depending on parameter being tested. Set at 6.5 volts when measuring V_{TM} (to allow maximum collector current) and set at 25 volts when measuring I_{GT} and V_{GT}.
If voltage range is 75 volts,	set at 100 volts.
If voltage range is 1500 volts,	set at 1600 volts.

MODEL 370 CURVE TRACER PROCEDURE NOTES

The curve tracer procedure was actually written for the TEKTRONIX Model 576 curve tracer. Also, the *Variable Collector Supply Voltage Range* and *Power Dissipation* controls have different scales between the two different models. However, if the following guidelines are followed, the Model 370 can be used just as easily.

Model 576	Model 370
If power dissipation is 0.1 watts,	set at 0.08 watts.
If power dissipation is 0.5 watts,	set at 0.4 watts.
If power dissipation is 2.2 watts,	set at 2.0 watts.
If power dissipation is 10 watts,	set at 10 watts.
If power dissipation is 50 watts,	set at 50 watts.
If power dissipation is 220 watts,	set at 220 watts.

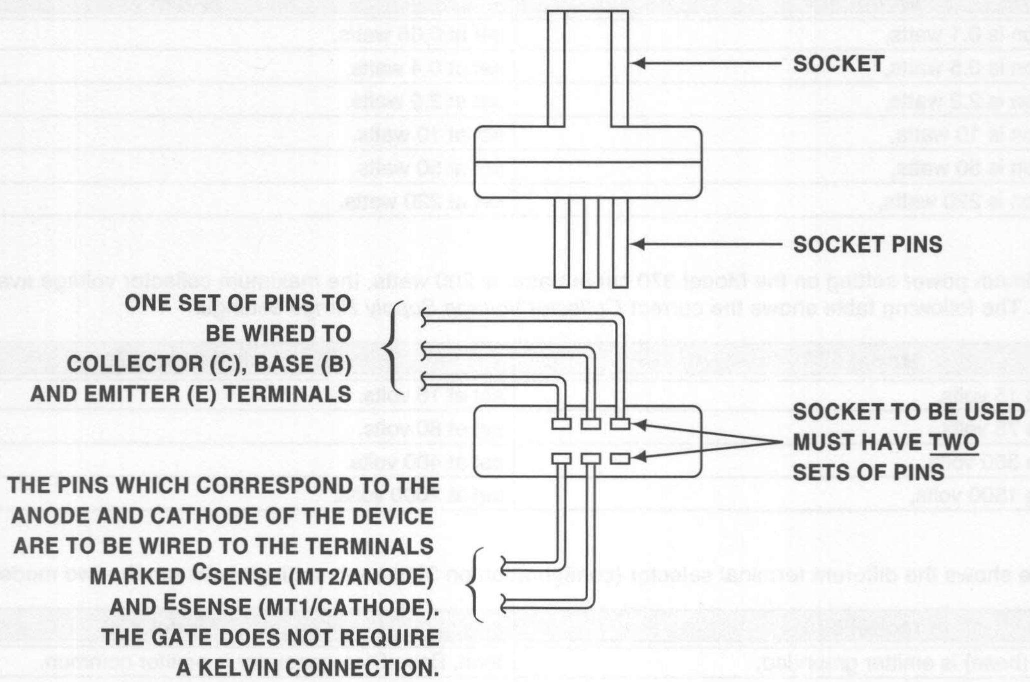
Although the maximum power setting on the Model 370 curve tracer is 200 watts, the maximum collector voltage available is only 400 volts at 220 watts. The following table shows the correct *Collector Voltage Supply Range* settings:

Model 576	Model 370
If voltage range is 15 volts,	set at 16 volts.
If voltage range is 75 volts,	set at 80 volts.
If voltage range is 350 volts,	set at 400 volts.
If voltage range is 1500 volts,	set at 2000 volts.

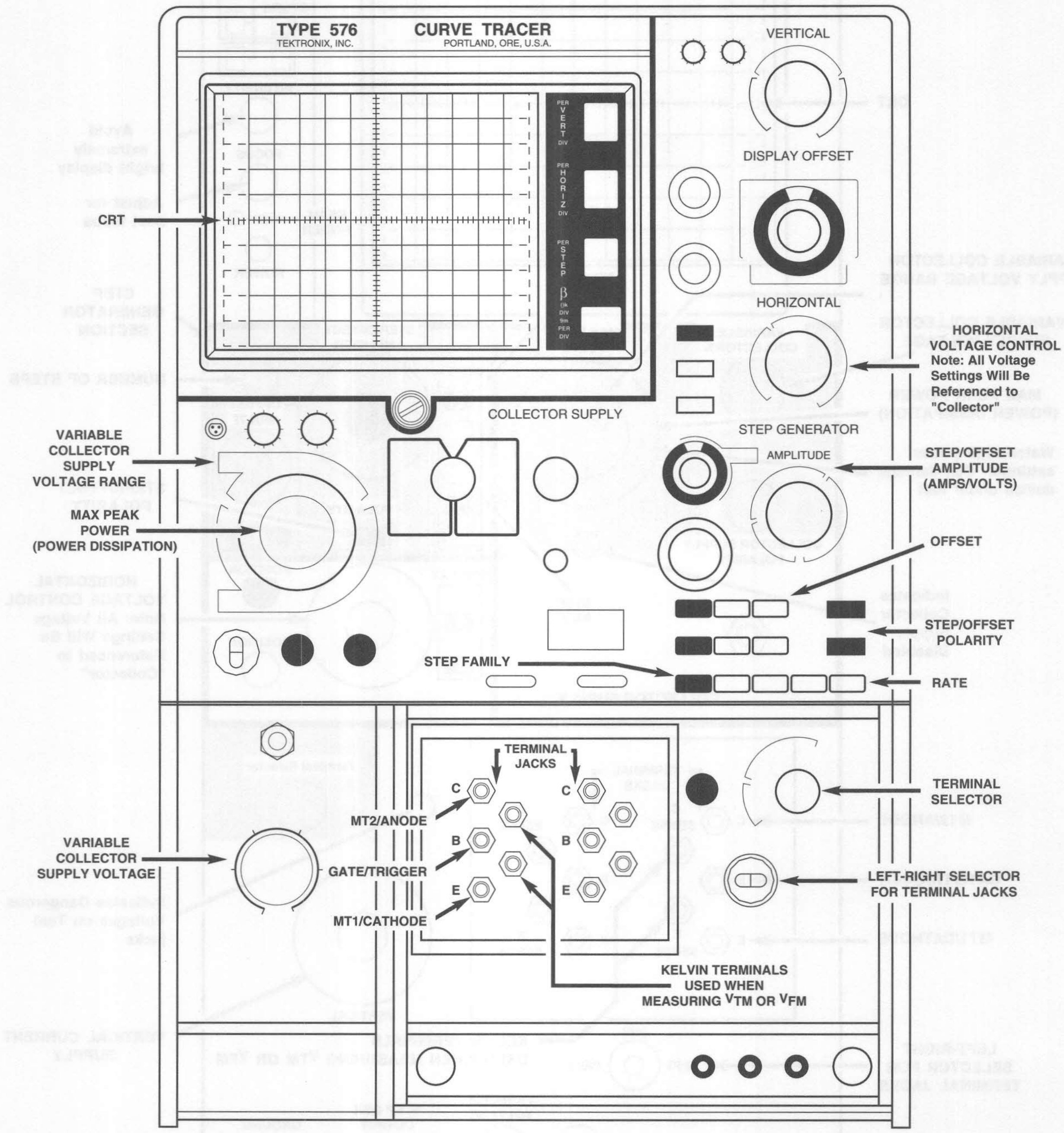
The following table shows the different terminal selector (configuration on 370) knob settings between the two models:

Model 576	Model 370
If Step generator (base) is emitter grounded,	then, Base Step generator is emitter common.
If Emitter grounded is open base,	then, Base open is emitter common.

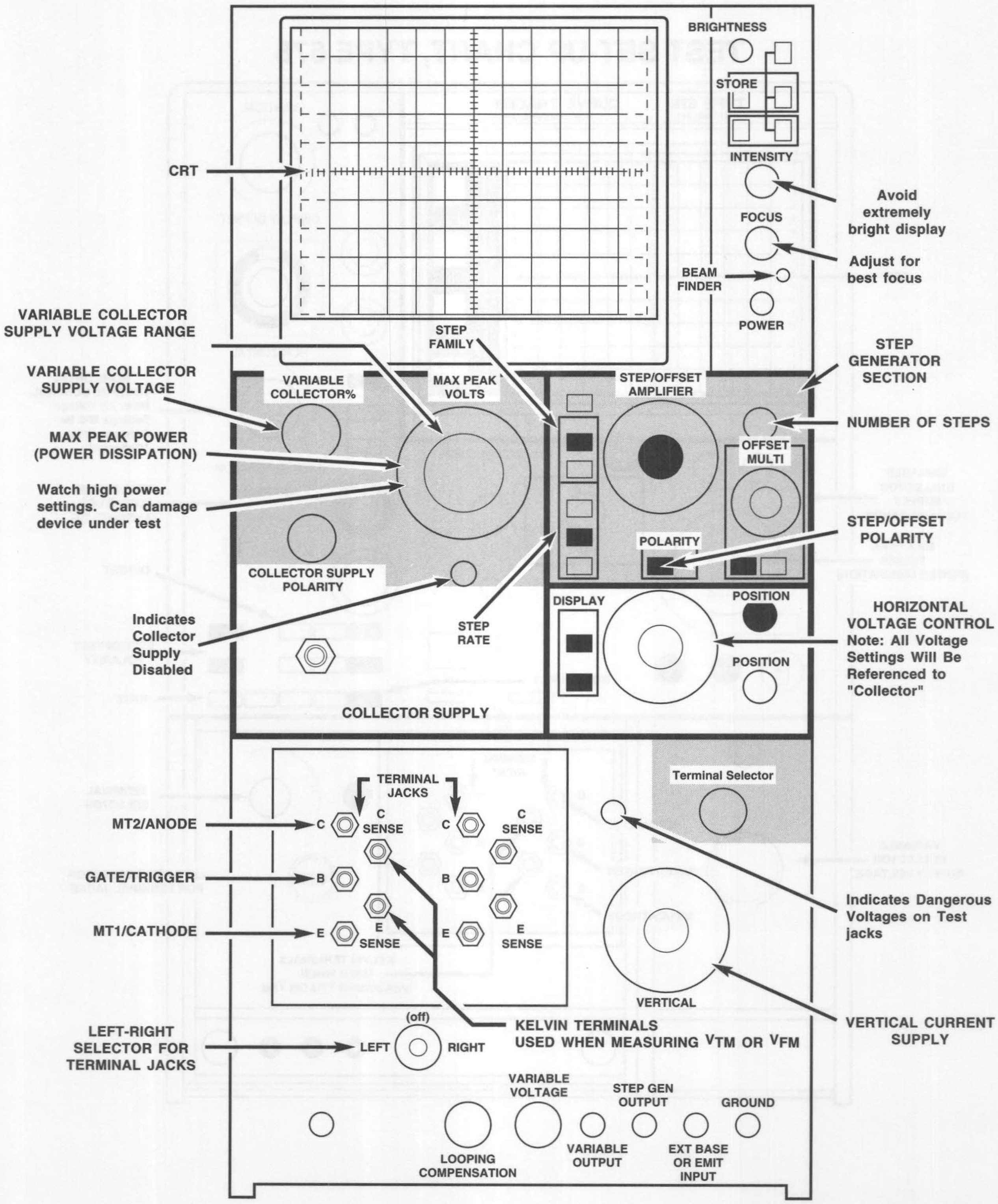
INSTRUCTIONS FOR WIRING
KELVIN SOCKET



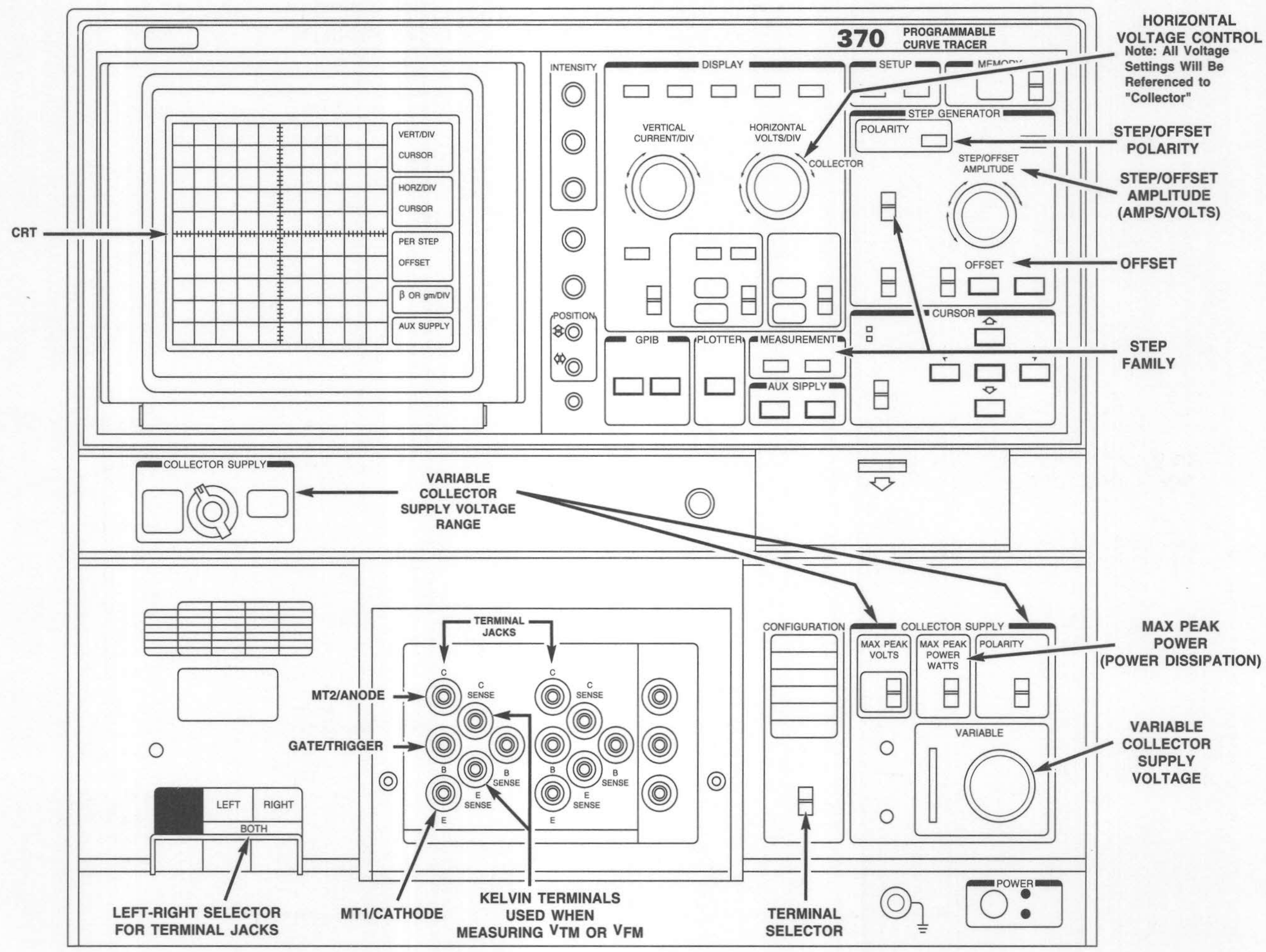
TEST SET-UP CHART, TYPE 576



TEST SET-UP CHART, TYPE 577



TEST SET-UP CHART, TYPE 370



Notes

Thyristors Used As AC Static Switches and Relays

Introduction

Since the SCR and the triac are bistable devices, one of their broad areas of application is in the realm of signal and power switching. This application note describes circuits in which these thyristors are used to perform simple switching functions of a general type that might also be performed non-statically by various mechanical and electromechanical switches. In these applications, the thyristors are used to open or close a circuit completely, as opposed to applications in which they are used to control the magnitude of average voltage or energy being delivered to a load. These latter types of application are covered in detail in Application Note AN1003.

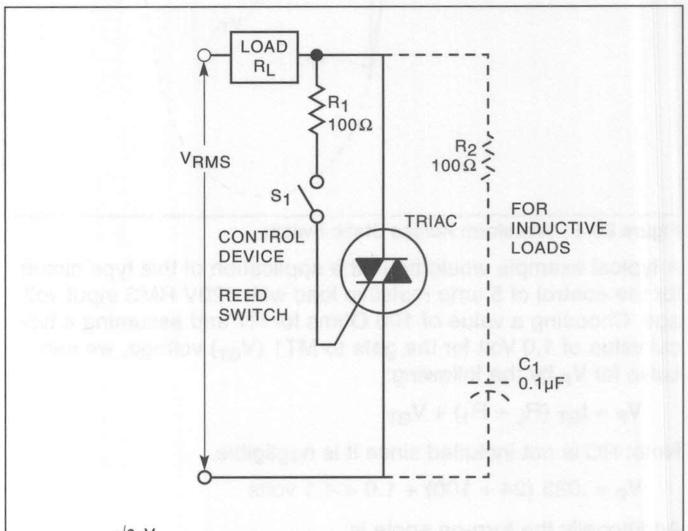
Static Ac Switches

Normally Open Circuit

The circuit of Figure 20.1 provides random (anywhere in half-cycle) fast turn-on (<10μs) of AC power loads and is ideal for applications with a high duty cycle. It eliminates completely the contact sticking, bounce, and wear associated with conventional electromechanical relays, contactors, etc. As a substitute for control relays, thyristors can overcome the differential problem; that is, the spread in current or voltage between pickup and dropout because thyristors effectively drop out every half-cycle. Also, providing resistor R_1 is chosen correctly, the circuits are operable over a much wider voltage range than is a comparable relay. Resistor R1 is provided to limit gate current (I_{GTM}) peaks. Its resistance plus any "contact" resistance (R_C) of the control device and load resistance (R_L) should be just greater than the peak supply voltage divided by the peak gate current rating of the triac. If R_1 is made too high, the triacs may not trigger at the beginning of each cycle, and "phase control" of the load will result with consequent loss of load voltage and waveform distortion. For inductive loads, an RC snubber circuit, as shown, is required. However, a snubber circuit is not required when an alternistor is used.

To better understand a typical static switch circuit, the following analysis can be made.

Figure 20.2 circuit operation occurs when switch S_1 is closed, the triac, thyristor Q_1 will initially be in the blocking condition. Current flow will be through load R_L, S_1, R_1, and gate to MT1 junction of the thyristor. When this current reaches the required value of I_{GT}, the MT2 to MT1 junctions will switch to the conduction state and the voltage from MT2 to MT1 will be V_T. As the current approaches the zero crossing, the load current will fall below holding current turning the triac (Q_1) device off until it is refired in the next half cycle. Figure 20.3 illustrates the voltage waveform appearing across the MT2 to MT1 terminals of Q1. It should be noted that the maximum peak value of current which S1 will carry would be 25 mA since Q1 has a 25 mA maximum IGT rating. Additionally, there will be no arcing of a current value greater than 25 mA when opening S1 when controlling an inductive load. It is important to note that the triac (Q1) is operating in Quadrants I and III, the more sensitive and most suitable gating modes for triacs. The voltage rating of S1 (mechanical switch or reed switch) must be equivalent to or greater than line voltage applied.



$$R_1 \geq \frac{\sqrt{2}\bullet V}{I_{GTM}} - (R_L + R_C)$$ WHERE I_{GTM} IS PEAK GATE CURRENT RATING OF TRIAC

Figure 20.1 Basic Triac Static Switch

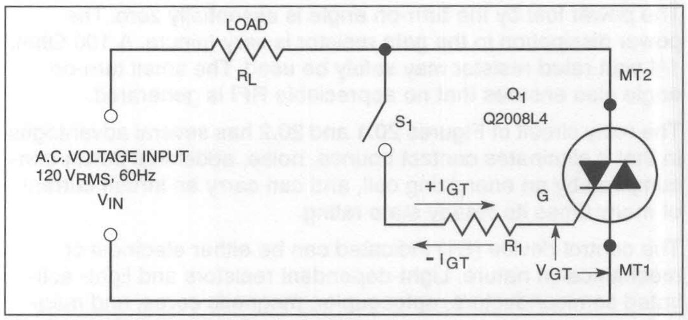


Figure 20.2 Analysis of Static Switch

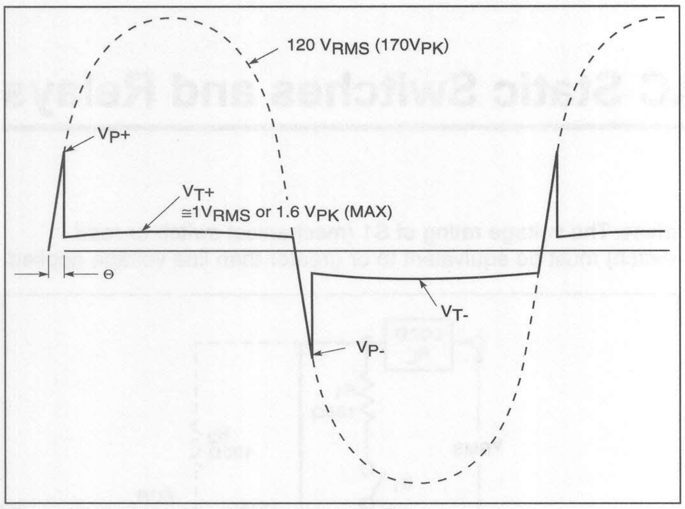


Figure 20.3 Waveform Across Static Switch

A typical example would be in the application of this type circuit for the control of 5 amp resistive load with 120V RMS input voltage. Choosing a value of 100 Ohms for R1 and assuming a typical value of 1.0 Volt for the gate to MT1 (V_{GT}) voltage, we can solve for V_P by the following:

$$V_P = I_{GT}(R_L + R_1) + V_{GT}$$

Note: RC is not included since it is negligible.

$$V_P = .025\,(24 + 100) + 1.0 = 4.1 \text{ volts}$$

Additionally the turn-on angle is

$$\theta = Sin^{-1}\frac{4.1}{170V_{PK}} \qquad [\theta = 1.4^\circ]$$

The power lost by the turn-on angle is essentially zero. The power dissipation in the gate resistor is very minute. A 100 Ohm, 1/4 watt rated resistor may safely be used. The small turn-on angle also ensures that no appreciable RFI is generated.

The relay circuit of Figures 20.1 and 20.2 has several advantages in that it eliminates contact bounce, noise, additional power consumption by an energizing coil, and can carry an inrush current of many times its steady state rating.

The control device (S1) indicated can be either electrical or mechanical in nature. Light-dependent resistors and light- activated semiconductors, optocoupler, magnetic cores, and magnetic reed switches are all suitable control elements. Regardless of switch type chosen, it must have a voltage rating equal to or greater than the peak line voltage applied. In particular, the use of hermetically sealed reed switches as control elements in combination with triacs offers many advantages. The reed switch can be actuated by passing DC current through a small winding around it or by the proximity of a small magnet. In either case, complete electrical isolation exists between the control signal input, which may be derived from many sources, and the switched power output. Long life is assured the triac/reed switch combination by the minimal volt-ampere switching load placed on the reed switch by the triac triggering requirements. The thyristor ratings determine the amount of load power that can be switched.

Normally Closed Circuit

With a few additional components, the thyristor can provide a normally closed static switch function. The critical design portion of this static switch is a clamping device to turn off/eliminate gate drive and maintain very low power dissipation through the clamping component plus have low by-pass leakage around the power thyristor device. In selecting the power thyristor for load requirements, gate sensitivity becomes critical to maintain low power requirements. Either sensitive SCRs or sensitive logic triacs must be considered which limits the load in current capacity and type. However, this can be broader if an extra stage of circuitry for gating is permitted.

Figure 20.4 represents an application using a normally closed circuit driving a sensitive SCR for a simple but precise temperature controller. The same basic principle could be applied to a water level controller for a motor or solenoid. Of course, SCR and diode selection would be changed depending on load current requirements.

A mercury-in-glass thermostat is an extremely sensitive measuring instrument, capable of sensing changes in temperature as small as 0.1˚C. Its major limitation lies in its very low current handling capability for reliability and long life, contact current should be held below 1 mA. In the circuit of Figure 20.4, the S2010LS2 SCR serves as both current amplifier for the Hg thermostat and as the main load switching element.

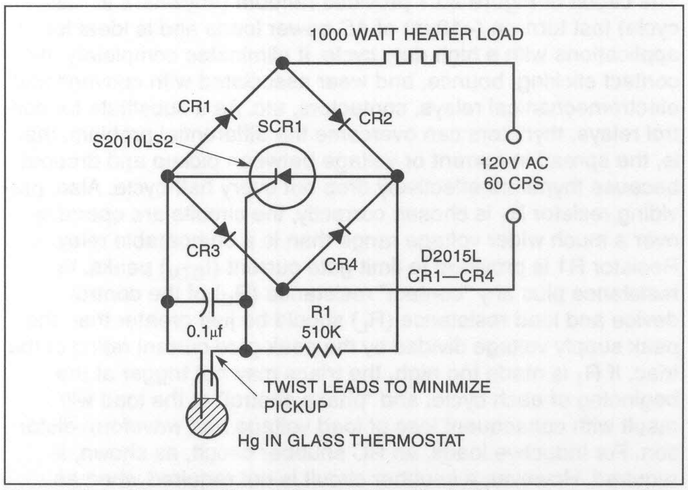


Figure 20.4 Normally Closed Temperature Controller

With the thermostat open, the SCR will trigger each half cycle and deliver power to the heater load. When the thermostat closes, the SCR can no longer trigger and the heater shuts off. Maximum current through the thermostat in the closed position is less than 250 µA RMS.

Figure 20.5 is an all solid state, optocoupled, normally closed switch circuit. By using a low voltage SBS triggering device, this circuit can turn on with only a small delay in each half cycle and also keep gating power low. When the optocoupled transistor is turned on, the gate drive is removed with only a few milliamps of by-pass current around the triac power device. Also by use of the 2N4991 and 0.1 µF, less sensitive triacs and alternistors can be used to control various types of high current loads.

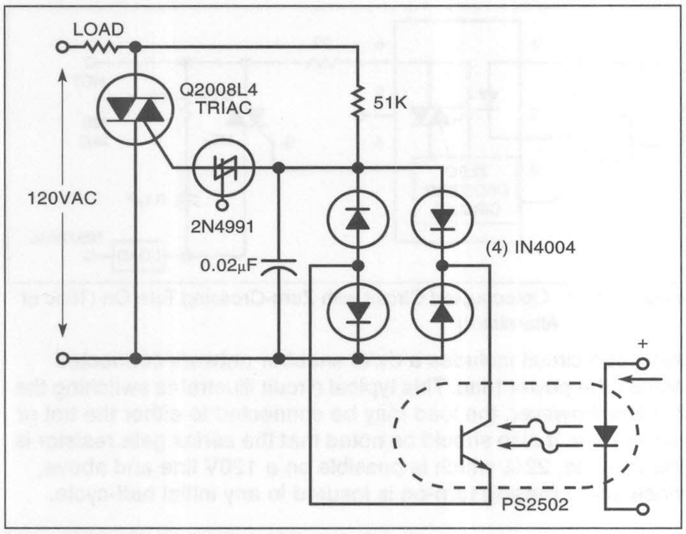


Figure 20.5 Normally Closed Switch Circuit

Optocoupled Driver Circuits

Random Turn-On, Normally-Open

There are many applications which use optocouplers to drive thyristors. The combination of a good optocoupler and a triac or alternistor makes an excellent, inexpensive solid state relay. The optocoupler manufacturers supply application information which is not always best for application of the power thyristor. A standard circuit for a resistive load is shown in Figure 20.6.

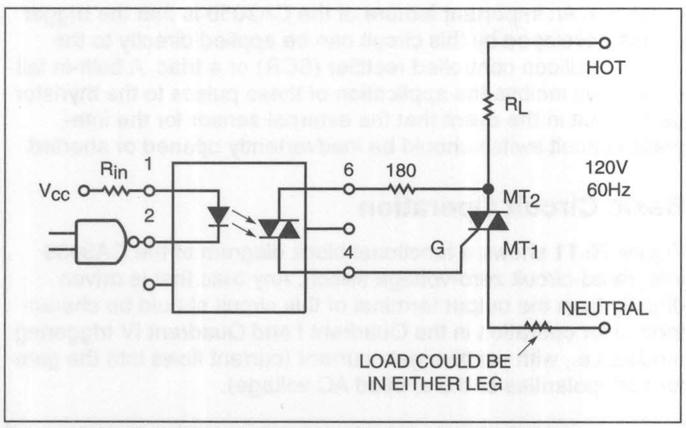


Figure 20.6 Optocoupled Circuit for Resistive Loads (Triac or Alternistor)

A common mistake in this circuit is to make the series gate resistor too large in value. A value of 180Ω is shown in a typical application circuit by optocoupler manufacturers. The 180Ω is based on limiting the current to 1 Amp peak at the peak of a 120V line input. This is good for protection of the optocoupler output triac, as well as the gate of the power triac on a 120V line; however, it must be lowered if a 24V line is being controlled, or if the R_L (resistive load) is 200 watts or less. This resistor limits current for worst case turn- on at the peak line voltage, but it also sets turn-on point (conduction angle) in the sine wave, since triac gate current is determined by this resistor and produced from the sine wave voltage as explained in Figure 20.2 of this application note. The load resistance is also important, since it can also limit the amount of available triac gate current. In most 120V applications with loads greater than 200 watts, and optocouplers from Quality Technologies or Siemens with optocoupler output triacs which can handle $1.7A_{pk}$ for a few microseconds at the peak of the line, a 100Ω gate resistor would be a better choice. For loads less than 200 watts, the resistor can be dropped to 22Ω. Remember, if the gate resistor is too large in value, the triac will not turn on at all or not turn on fully which can cause excessive power dissipation in the gate resistor, causing it to burn out. Also the voltage and dv/dt rating of the optocoupler's output device must be equal to or greater than the voltage and dv/dt rating of triac or alternistor it is driving.

Figure 20.7 offers a circuit with a dv/dt snubber network included. This is a typical circuit presented by optocoupler manufacturers.

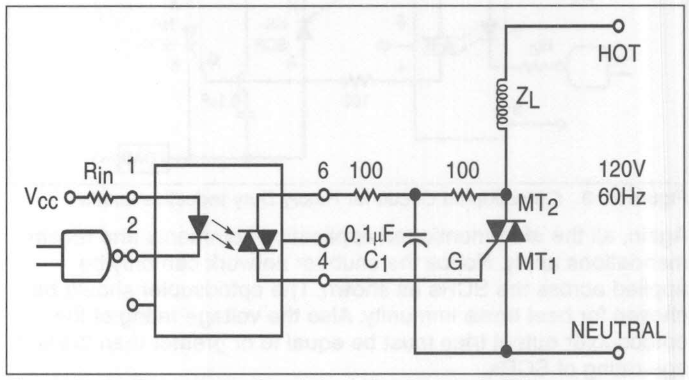


Figure 20.7 Optocoupler Circuit for Inductive Loads (Triac or Alternistor)

This clever "T" circuit hinges around one capacitor to increase dv/dt capability to either the optocoupler output triac or the power triac. The sum of the two resistors then forms the triac gate resistor. Note: both resistors should then be standardized and lowered to 100Ω. Again, this sum resistance needs to be low, allowing as much gate current as possible without exceeding the instantaneous current rating of the opto output triac or triac gate junction. By having 100Ω for current limit in either direction from the capacitor, the optocoupler output triac and power triac can be protected against di/dt produced by the capacitor. Of course, it is most important that the capacitor be connected between proper terminals of triac. For example, if the capacitor and series resistor are accidentally connected between the gate and MT2, the triac will turn on from current produced by the capacitor, hence, loss of control.

For low current (mA) and/or highly inductive loads, it may be necessary to have a latching network connected directly across the power triac. The circuit in Figure 20.8 illustrates the additional latching network.

In this circuit, the series gate resistors have been increased to 180Ω each, since a 240V line is applied. Also, note that the load is placed on the MT1 side of the power triac to illustrate that load placement is ***not*** important for the circuit to function properly.

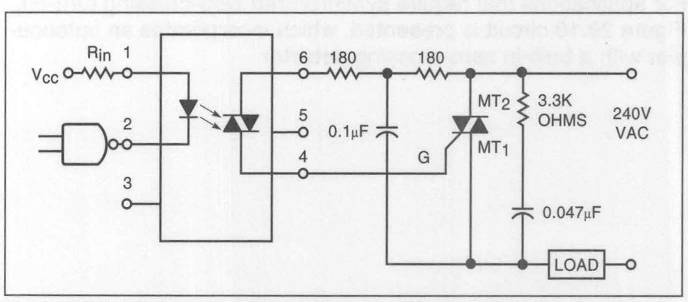


Figure 20.8 Optocoupler Circuit for Lower Current Inductive Loads (Triac or Alternistor)

It should be also noted, that with standard U.S. residential 240V home wiring, both sides of the line are hot with respect to ground (no neutral). Hence, for some 240V line applications, it will be necessary to have a triac switch circuit in both sides of the 240V line input.

If an application requires back-to-back SCRs instead of a triac or alternistor, the circuit shown in Figure 20.9 may be used.

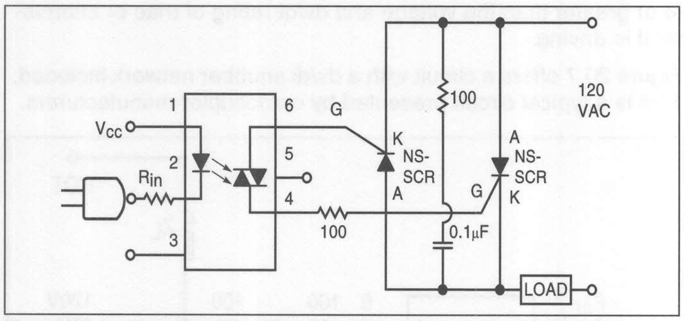


Figure 20.9 Optocoupled Circuit for Heavy Duty Inductive Loads

Again, all the aforementioned application comments and recommendations apply. Notice the snubber network can only be applied across the SCRs as shown. The optocoupler should be chosen for best noise immunity. Also the voltage rating of the optocoupler output triac must be equal to or greater than the voltage rating of SCRs.

Zero Crossing Turn-On, Normally Open Relay Circuits

When a power circuit is mechanically switched "on" and "off" mechanically, high frequency components are generated that can cause interference problems such as RFI. When power is initially applied, a step function of voltage is applied to the circuit which causes a shock excitation. Random switch opening chops current off, again generating high frequencies. In addition, abrupt current interruption in an inductive circuit can lead to high induced voltage transients.

The latching characteristics of thyristors are ideal for eliminating interference problems due to current interruption since these devices can only turn off when the on-state current approaches zero, regardless of load power factor.

On the other hand, interference-free turn-on with thyristors requires special trigger circuits. It has been proven experimentally that general purpose AC circuits will generate minimum electromagnetic interference (EMI) if energized at zero voltage.

The ideal AC circuit switch, therefore, consists of a contact which closes at the instant when voltage across it is zero and opens at the instant when current through it is zero. This has become known as "zero-voltage switching."

For applications that require synchronized zero-crossing turn-on, Figure 20.10 circuit is presented, which incorporates an optocoupler with a built-in zero-crossing detector

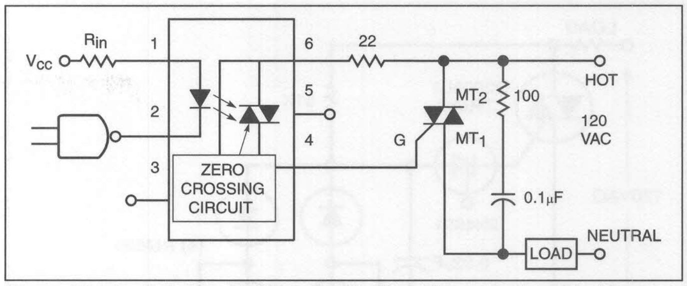


Figure 20.10 Optocoupled Circuit with Zero-Crossing Turn On (Triac or Alternistor)

Also, this circuit includes a dv/dt snubber network connected across the power triac. This typical circuit illustrates switching the hot line; however, the load may be connected to either the hot or neutral line. It also should be noted that the series gate resistor is low in value, 22Ω, which is possible on a 120V line and above, since zero-crossing turn-on is insured in any initial half-cycle.

Typical Solid State Controller Circuit Using Zero Switching

The CA3059 zero-voltage switch is a monolithic integrated circuit used primarily as a trigger circuit for the control of thyristors. The multistage circuit employs a diode limiter, a threshold detector, a differential amplifier, and Darlington output driver to provide the basic switching action. The DC supply voltage for these stages is supplied by an internal zener-diode-regulated power supply that has sufficient current capability to drive external circuit elements, such as transistors and other integrated circuits. This built-in power supply provides unique solutions to many application problems. An important feature of the CA3059 is that the trigger pulses developed by this circuit can be applied directly to the gate of a silicon controlled rectifier (SCR) or a triac. A built-in fail-safe circuit inhibits the application of these pulses to the thyristor gate circuit in the event that the external sensor for the integrated-circuit switch should be inadvertently opened or shorted.

Basic Circuit Operation

Figure 20.11 shows a functional block diagram of the CA3059 integrated-circuit zero-voltage switch. Any triac that is driven directly from the output terminal of this circuit should be characterized for operation in the Quadrant I and Quadrant IV triggering modes, i.e., with positive gate current (current flows into the gate for both polarities of the applied AC voltage).

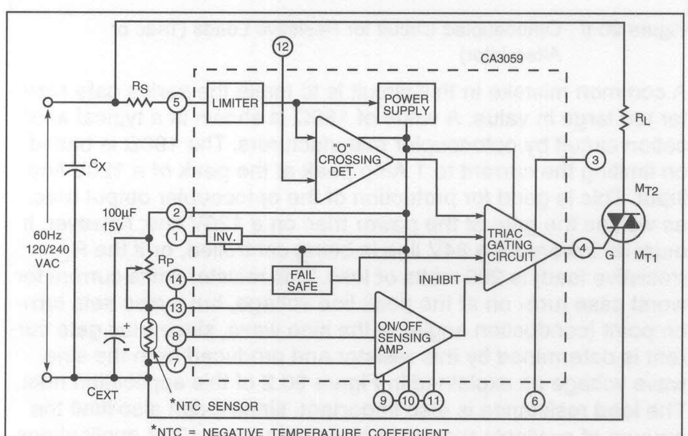


Figure 20.11 Zero-Switching Heat Controller

AC Input Voltage (volts) 50/60 or 400 Hz	Series Resistor R_S(kΩ)	Power Rating R_S(watts)
24	2	0.5
120	10	2
208/230	20	4
277	25	5

The limiter stage of the CA3059 clips the incoming AC line voltage to approximately plus and minus 8 Volts. This signal is then applied to the zero-voltage-crossing detector which generates an output pulse during each passage of the line voltage through zero. The limiter output is also applied to a rectifying diode and an external capacitor that comprise the DC power supply. The power supply provides approximately 6 Volts as the V_{CC} supply to the other stages of the CA3059. The on/off sensing amplifier is basically a differential comparator. The triac gating circuit contains a driver for direct triac triggering. The gating circuit is enabled when all the inputs are at a high voltage, i.e., the line voltage must be approximately zero Volts, the sensing-amplifier output must be "high", the external voltage to terminal 1 must be a logical "1", and the output of the fail-safe circuit must be "high." Figure 20.12 shows the position and width of the pulses supplied to the gate of a thyristor with respect to the incoming AC line voltage. The CA3059 can supply sufficient gate voltage and current to trigger most triacs at ambient temperatures of 25˚C. However, under worst-case conditions (i.e., at ambient temperature extremes and maximum triggering requirement), selection of the higher current thyristors may be necessary for particular applications.

Required Thyristor Characteristics Due To Load

The CA3059 is designed primarily to gate a thyristor that switches a resistive load. Because the output pulse supplied by the CA3059 is of short duration, the latching current of the triac becomes a significant factor in determining whether other types of loads can be switched. (The latching-current value determines whether the triac will remain in conduction after the gate pulse is removed.) Provisions are included in the CA3059 to accommodate inductive loads and low power loads. For example, for loads that are less than approximately 4 amperes RMS or that are slightly inductive, it is possible to retard the output pulse with respect to the zero-voltage crossing by insertion of the capacitor C_X from terminal 5 to terminal 7 as shown in Figure 20.11. The insertion of capacitor CX permits switching of triac loads that have a slight inductive component and that are greater than approximately 200 watts (for operation from an AC line voltage of 120 volts RMS). However, for loads less than 200 watts (for example, 70 watts), it is recommended that the user employ the sensitive gate triac with the CA3059 because of the low latching-current requirement of this triac.

For loads that have a low power factor, such as a solenoid valve, the user may operate the CA3059 in the DC mode. In this mode, terminal 12 is connected to terminal 7, and the zero-crossing detector is inhibited. Whether a "high" or "low" voltage is produced at terminal 4 is then dependent only upon the state of the differential comparator within the CA3059 integrated circuit and not upon the zero crossing of the incoming line voltage. Of course, in this mode of operation, the CA3059 no longer operates as a zero-voltage switch. However, for many applications that involve the switching of low-current inductive loads, the amount of RFI generated can frequently be tolerated.

Fail-Safe Feature

As shown in Figure 20.11, when terminal 13 is connected to terminal 14, the fail-safe circuit of the CA3059 is operable. If the sensor should then be accidentally opened or shorted, power is removed from the load (i.e., the triac is turned off). The internal fail-safe circuit functions properly, however, only when the ratio of the sensor impedance at 25˚C and potentiometer is less than 4 to 1.

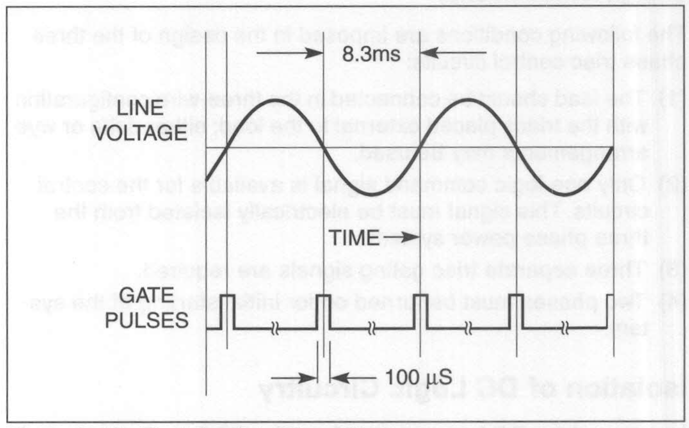


Figure 20.12 Thyristor Gate Signal Timing

For ratios greater than 4 to 1, for example 100 to 1, the circuit shown in Figure 20.13 may be employed to provide fail-safe operation. In this circuit, transistor Q_1 and diode D_1 are components external to the CA3059. Transistor Q_1 detects the sensor current which maintains this transistor in saturation so that terminal 1 is effectively shorted to terminal 7 through the collector-to-emitter junction of the transistor. Transistor Q_1 provides sufficient current gain to permit operation with a sensor impedance greater than 1 megohm. If the sensor becomes open-circuited, transistor Q_1 turns off, and current then flows into terminal 1, the inhibit terminal of the CA3059, and results in the removal of power to the load. For the shorted-sensor condition, the external diode D_1 conducts and causes the triac to turn off. Diode D_2 compensates for variations in the base-to-emitter voltage of transistor Q_1 with temperature. Terminals 13 and 14 on the CA3059 should not be connected together when the external fail-safe circuit shown in this illustration is employed.

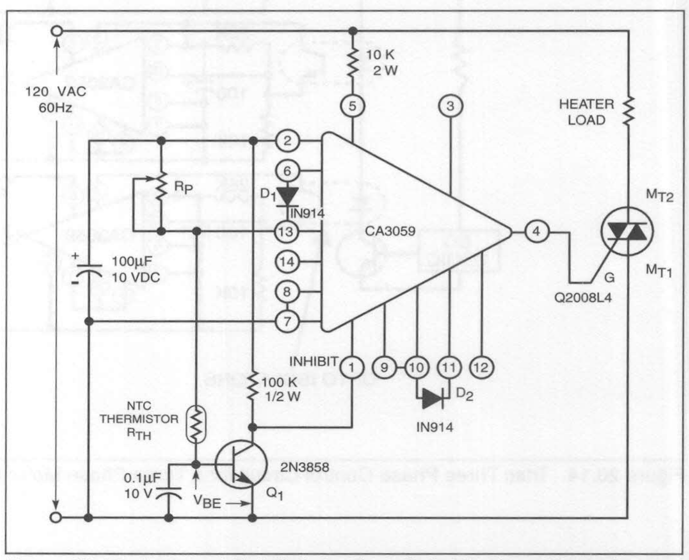


Figure 20.13 Improved Fail-Safe for Zero-Switching Heat Controller

Three Phase Controller

With the growing demand for solid-state switching of AC power in heating controls and other industrial applications has resulted in the increasing use of triac circuits in the control of three phase power. In these power-control circuits the CA3059 integrated-circuit zero-voltage switch can be used as the trigger circuit for the power triacs.

Design Requirements

The following conditions are imposed in the design of the three phase triac control circuits:

(1) The load should be connected in the three-wire configuration with the triacs placed external to the load; either delta or wye arrangements may be used.

(2) Only one logic command signal is available for the control circuits. This signal must be electrically isolated from the three phase power system.

(3) Three separate triac gating signals are required.

(4) Two phases must be turned on for initial starting of the system.

Isolation of DC Logic Circuitry

Isolation of the DC logic circuitry from the AC line, the triac, and the load circuit is often desirable even in many single-phase power-control applications. In control circuits for polyphase power systems, however, this type of isolation is essential, because the common point of the DC logic circuitry cannot be referenced to a common line in all phases. In a three phase system the phases are 120 degrees apart; consequently, all three phases cannot be switched on simultaneously at zero-voltage.

Typical Circuit

For inductive loads, zero-voltage turn-on is not generally required because the inductive current cannot increase instantaneously; therefore, the amount of RFI generated is usually negligible. Also, because of the lagging nature of the inductive current, the triacs cannot be pulse-fired at zero-voltage. There are several ways in which the CA3059 may be interfaced to a triac for inductive-load applications. The most direct approach is to use the CA3059 in the DC mode, i.e., to provide a continuous DC output instead of pulses at points of zero-voltage crossing. This mode of operation is accomplished by connection of terminal 12 to terminal 7, as shown in Figure 20.14. The output of the CA3059 should also be limited to approximately 5 milliamperes in the DC mode by the 750 Ohm series resistor. Use of a logic triac such as the L401E5 is recommended for this application. Terminal 3 is connected to terminal 2 to limit the steady-state power dissipation within the CA3059. For most three phase inductive load applications, the current-handling capability of the L401E5 triac (1.0 ampere) is not sufficient. Therefore, the L401E5 is used as a trigger triac to turn on any other currently available power triac or alternistor that may be used. The trigger triac is used only to provide trigger pulses to the gate of the power triac (one pulse per half-cycle); the power dissipation in this device, therefore, will be minimal.

Simplified circuits using pulse transformers and reed relays will also work quite satisfactorily in this type of application. The RC networks across the three power triacs are used for suppression of the commutating dv/dt when the circuit operates into inductive loads; however, when alternistor power devices are used a snubber network most probably is not necessary.

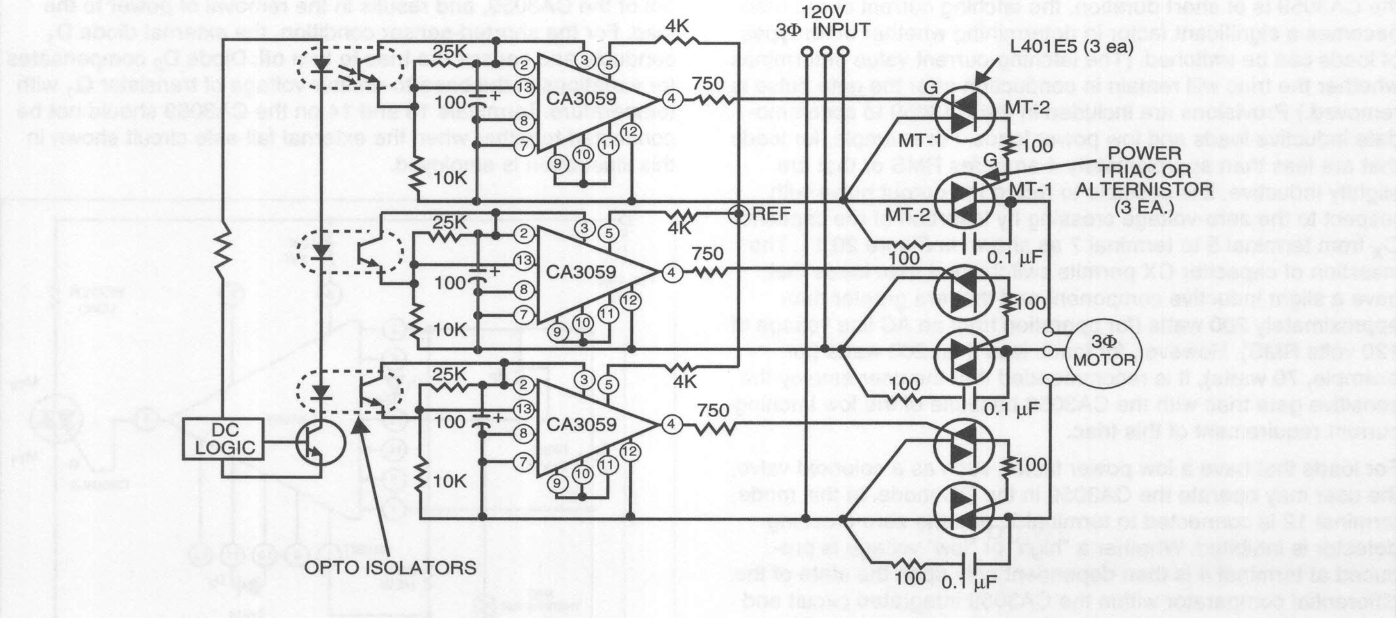


Figure 20.14 Triac Three Phase Control Circuit for a Three Phase Motor Load

Explanation of Maximum Ratings for Thyristors

Data sheets for SCRs and triacs give vital information regarding maximum ratings and characteristics of thyristors. If the ***maximum ratings*** of the thyristors are surpassed, possible irreversible damage may occur. The characteristics describe various pertinent device parameters which are guaranteed as either minimums or maximums. Some of these characteristics relate to the ratings but are not ratings in themselves. The characteristic does not define what the circuit must provide or be restricted to but defines the device characteristic. For example, a minimum value is indicated for the dv/dt because this value depicts the guaranteed worst-case limit for all devices of the specific type. This minimum dv/dt value represents the maximum limit that the circuit should allow.

V_{RRM}: Peak Repetitive Reverse Voltage

SCR: The peak repetitive reverse voltage rating is the maximum peak reverse voltage that may be continuously applied to the main terminals (anode, cathode) of an SCR (see Figure 21.1). An open-gate condition and gate resistance termination is designated for this rating. An increased reverse leakage can result due to a positive gate bias during the reverse voltage exposure time of the SCR. The repetitive peak reverse voltage rating relates to case temperatures up to the maximum rated junction temperature.

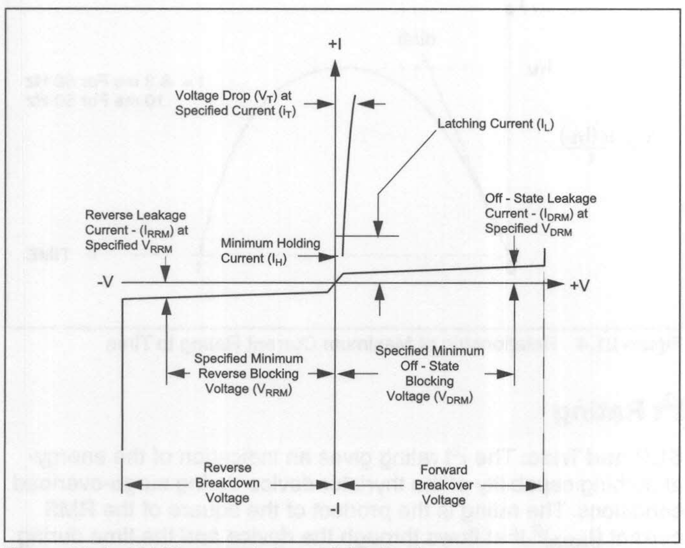


Figure 21.1 V-I Characteristics of SCR Device

V_{DRM}: Peak Repetitive Forward (Off-State) Voltage

SCR: The peak repetitive forward (off-state) voltage rating, (see Figure 1) refers to the maximum peak forward voltage which may be continuously applied to the main terminals (anode, cathode) of an SCR. This rating represents the maximum voltage the SCR should be required to block in the forward direction. The SCR may or may not go into conduction at voltages above the VDRM rating. This rating is specified for an open-gate condition and gate resistance termination. A positive gate bias should be avoided since it will reduce the forward-voltage blocking capability. The peak repetitive forward (off-state) voltage rating applies for case temperatures up to the maximum rated junction temperature.

Triac: The peak repetitive off-state voltage rating should not be surpassed on a typical, non-transient, working basis (see Figure 21.2). VDRM should not be exceeded even instantaneously. This rating applies for either positive or negative bias on main terminal 2 at the rated junction temperature. This voltage is less than the minimum breakover voltage so that breakover will not occur during operation. Leakage current is controlled at this voltage so that the temperature rise due to leakage power does not contribute significantly to the total temperature rise at rated current.

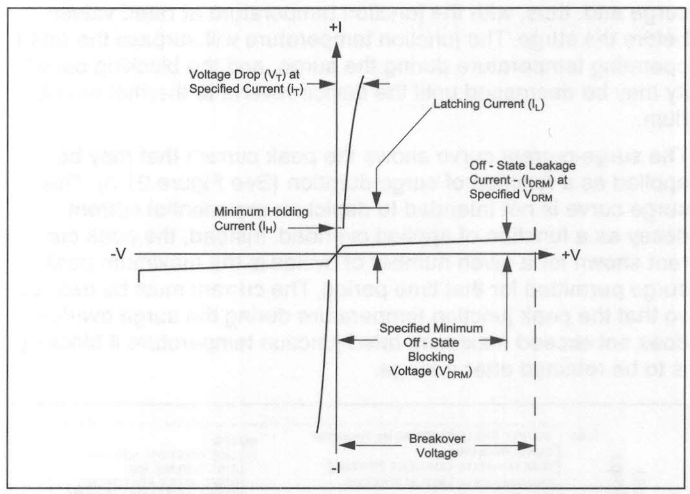


Figure 21.2

I_T Current Rating

SCR: For RMS and average currents, the restricting factor is usually confined so that the power dissipated during the on-state and as a result of the junction-to-case thermal resistance will not produce a junction temperature in excess of the maximum junction temperature rating. Power dissipation is changed to RMS and average current ratings for a 60-Hz sine wave with a 180˚ conduction angle. The average current for conduction angles less than 180˚ is derated because of the higher RMS current connected with high peak currents. The DC current rating is higher than the average value for 180˚ conduction since no RMS component is present.

There are several ways to determine the dissipation for non-sinusoidal waveshapes. Graphically plotting instantaneous dissipation as a function of time is one method used. The total maximum allowable power dissipation P_D may be determined using the following equation for temperature rise:

$$P_D = \frac{I_{J(MAX)} - I_C}{R_{\theta JC}}$$

where T_J(max) is the maximum rated junction temperature (at zero rated current), T_C is the actual operating case temperature, and $R_{\theta JC}$ is the published junction-to-case thermal resistance. Transient thermal resistance curves are required for short interval pulses.

Triac: The limiting factor for RMS current is determined by multiplying power dissipation by thermal resistance. The resulting current value will ensure an operating junction temperature within maximum value. For convenience, dissipation is converted to RMS current at a 360˚ conduction angle. The same RMS current can be used at a conduction angle of less than 360˚. For information on non-sinusoidal waveshapes and a discussion of dissipation, refer to the preceding description of SCR current rating.

I_{TSM}: Peak Surge (Non-Repetitive) On-State Current

SCR and Triac: The peak surge current is the maximum peak current that may be applied to the device for one full cycle of conduction without device degradation. The maximum peak current is usually specified as sinusoidal at 50 or 60 Hz. This rating applies when the device is conducting rated current before the surge and, thus, with the junction temperature at rated values before the surge. The junction temperature will surpass the rated operating temperature during the surge, and the blocking capacity may be decreased until the device reverts to thermal equilibrium.

The surge-current curve shows the peak current that may be applied as a function of surge duration (See Figure 21.3). This surge curve is not intended to depict an exponential current decay as a function of applied overload. Instead, the peak current shown for a given number of cycles is the maximum peak surge permitted for that time period. The current must be derated so that the peak junction temperature during the surge overload does not exceed maximum rated junction temperature if blocking is to be retained after a surge.

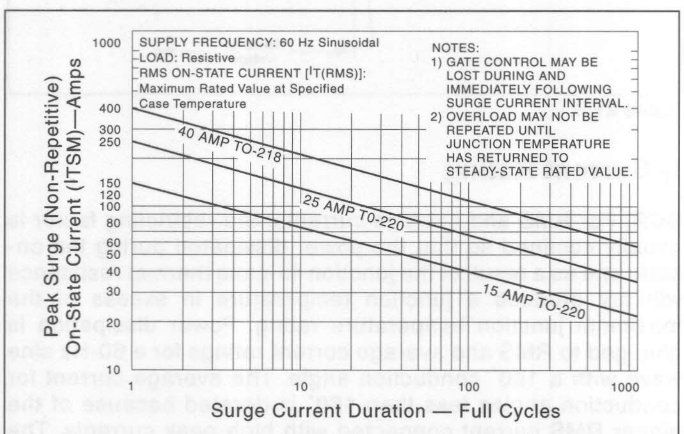


Figure 21.3 Peak Surge Current vs Surge Current Duration

I_{TM}: Peak Repetitive On-State Current

SCR and Triac: The I_{TM} rating specifies the maximum peak current that may be applied to the device during brief pulses. When the device operates under these circumstances, blocking capability is maintained. The minimum pulse duration and shape are defined and control the applied di/dt. The operating voltage, the duty factor, the case temperature, and the gate waveform are also defined. This rating must be followed when high repetitive peak currents are employed, such as in pulse modulators, capacitive-discharge circuits, and other applications where snubbers are required.

di/dt: Rate-of-Change of Forward Current

SCR and Triac: The di/dt rating specifies the maximum rate of rise of current through a thyristor device during turn-on. The value of principal voltage prior to turn-on and the magnitude and rise time of the gate trigger waveform during turn-on are among the conditions under which the rating applies. If the rate of change of current (di/dt) exceeds this maximum value, or if turn-on with high di/dt during minimum gate drive, dv/dt, or overvoltage occurs, then device degradation may occur as a result of localized heating.

During the first few microseconds of initial turn-on, the effect of di/dt is more pronounced. The di/dt capability of the thyristor is greatly increased as soon as the total area of the pellet is in full conduction.

The di/dt effects that can occur as a result of voltage or transient turn-on (non-gated) is not related to this rating. The di/dt rating is specified for maximum junction temperature.

The di/dt of a surge current can be calculated by means of the following equation (See Figure 21.4):

$$\frac{di}{dt} = \frac{\pi(I_{TM})}{t}$$

As example, surge current of 400 amperes at 60 Hz has a di/dt of π400/8.3 or 151.4 A/ms.

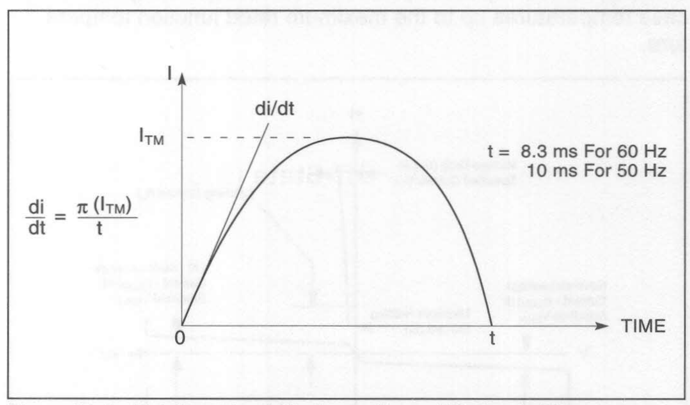


Figure 21.4 Relationship of Maximum Current Rating to Time

I^2t Rating

SCR and Triac: The I^2t rating gives an indication of the energy-absorbing capability of the thyristor device during surge-overload conditions. The rating is the product of the square of the RMS current $(I_{RMS})^2$ that flows through the device and the time during which the current is present and is expressed in A^2s. This rating is given for fuse selection purposes. It is important that the I^2t rating of the fuse is less than that of the thyristor device. Without proper fuse or current limit, overload or surge current will permanently damage the device due to excessive junction heating.

P_G: Gate Power Dissipation

SCR and Triac: Gate power dissipation ratings define both the peak power (P_{GM}) forward or reverse and the average power [$P_{G(AV)}$] that may be applied to the gate. Damage to the gate can occur if these ratings are not observed. The width of the applied

gate pulses must be considered in calculating the voltage and current allowed since the peak power allowed is a function of time. The peak power that results from a given signal source relies on the gate characteristics of the specific unit. The average power resulting from high peak powers must not exceed the average-power rating.

Temperature Range

SCR and Triac: The maximum storage temperature (T_S) is greater than the maximum operating temperature (actually maximum junction temperature). Maximum storage temperature is restricted by material limits defined not so much by the silicon but by peripheral materials such as solders used on the chip/die and lead attachments as well as the encapsulating epoxy. The forward and off-state blocking capability of the device determines the maximum junction (T_J) temperature. Maximum blocking voltage and leakage current ratings are established at elevated temperatures near maximum junction temperature; therefore, operation in excess of these limits may result in unreliable operation of the thyristor.

Characteristics

V_{BO}: Instantaneous Breakover Voltage

SCR and Triac: Breakover voltage (see Figure 1) is the voltage at which a device would turn on (switch to on-state by voltage breakover). This value applies for open-gate or gate resistance termination. Positive gate bias lowers the breakover voltage. Breakover is temperature sensitive and will occur at a higher voltage if the junction temperature is kept below maximum T_J value. If SCRs and Triacs are turned on as a result of an excess of breakover voltage, instantaneous power dissipations may be produced that can damage the chip/die.

I_{DRM}: Peak Repetitive Off-State (Blocking) Current

SCR: I_{DRM} is the maximum leakage current permitted through the SCR when the device is forward biased with rated positive voltage on the anode (DC or instantaneous) at rated junction temperature and with the gate open or gate resistance termination. A one thousand ohm resistor connected between gate and cathode is required on all sensitive SCRs. Leakage current decreases with decreasing junction temperatures. Effects of the off-state leakage currents on the load and other circuitry must be considered for each circuit application. Leakage currents can usually be ignored in applications that control high power.

Triacs: The description of peak off-state (blocking/leakage) current is the same for the triac as for the SCR except that it applies with either positive or negative bias on main terminal 2. (See Figure 21.2.)

I_{RRM}: Peak Repetitive Reverse Current

SCR: This characteristic is essentially the same as the peak forward off-state (blocking/leakage) current except negative voltage is applied to the anode (reverse biased).

V_{TM}: Peak On-State Voltage

SCR and Triac: The instantaneous on-state voltage (forward drop) is the principal voltage at a specified instantaneous current and case temperature when the thyristor is in the conducting state. To prevent heating of the junction, this characteristic is measured with a short current pulse. Note the current pulse should be at least 100 microseconds duration to ensure the device is in full conduction. The forward-drop characteristic determines the on-state dissipation (see Figure 5 and also refer to the preceding paragraph concerning current rating, I_T).

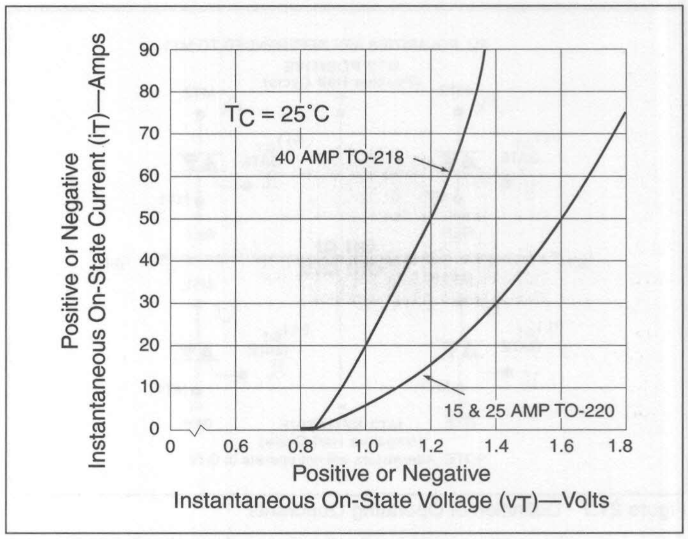


Figure 21.5 On-State Current vs On-State Voltage (Typical)

I_{GT}: DC Gate Trigger Current

SCR: I_{GT} is the minimum DC gate current required to cause the thyristor to switch from the non-conducting to the conducting state for a specified load voltage and current as well as case temperature. Figure 21.6 characteristic curve shows that trigger current is temperature dependent. The thyristor becomes less sensitive (requires more gate current) with decreasing junction temperatures. The gate current should be increased by a factor of 2 to 5 times the minimum threshold DC trigger current for best operation. Where fast turn-on is demanded and high di/dt is present or low temperatures are expected, the gate pulse may be 10 times the minimum I_{GT}, plus it must be fast rising and of sufficient duration in order to properly turn on the thyristor.

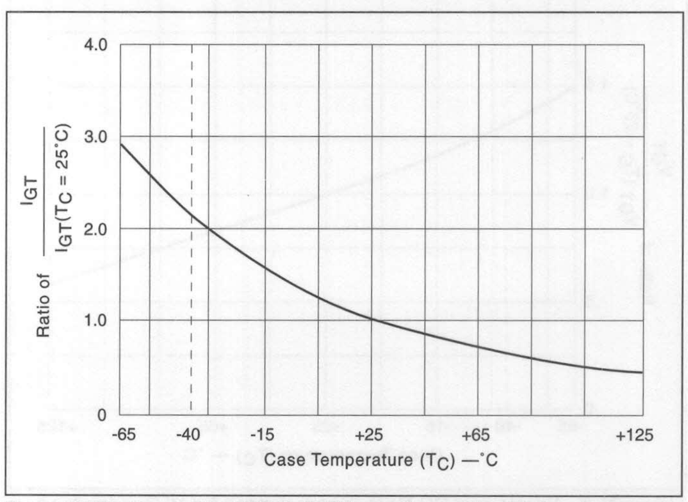


Figure 21.6 Normalized DC Gate Trigger Current for All Quadrants vs Case Temperature

Triac: The description for the SCR applies as well to the triac with the addition that the triac can be fired in four possible modes (Figure 21.7):

Quadrant I (main terminal 2 positive, gate positive)

Quadrant II (main terminal 2 positive, gate negative)

Quadrant III (main terminal 2 negative, gate negative)

Quadrant IV (main terminal 2 negative, gate positive)

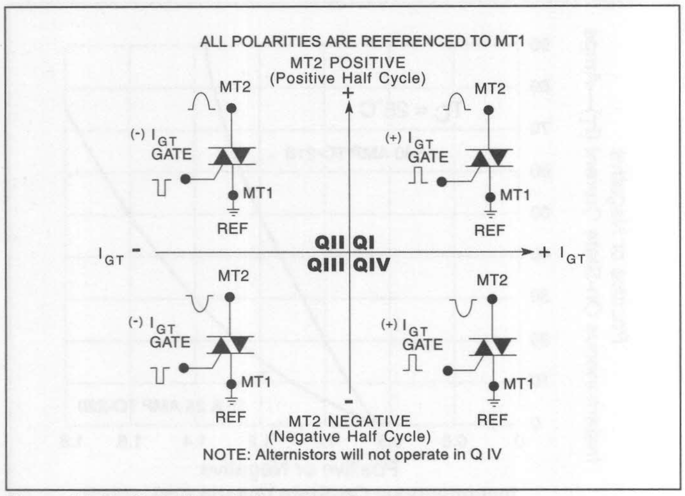


Figure 21.7 Definition of Operating Quadrants

V_{GT}: DC Gate Trigger Voltage

SCR: V_{GT} is the DC gate-cathode voltage that is present just prior to triggering when the gate current equals the DC trigger current. As shown in the characteristic curve (see Figure 21.8), the gate trigger voltage is higher at lower temperatures. The gate-cathode voltage drop can be higher than the DC trigger level if the gate is driven by a current higher than the trigger current.

Triac: The difference in V_{GT} for the SCR and the triac is that the triac can be fired in four possible modes. There can be a slight difference in the threshold trigger voltage depending which of the four operating modes is actually used.

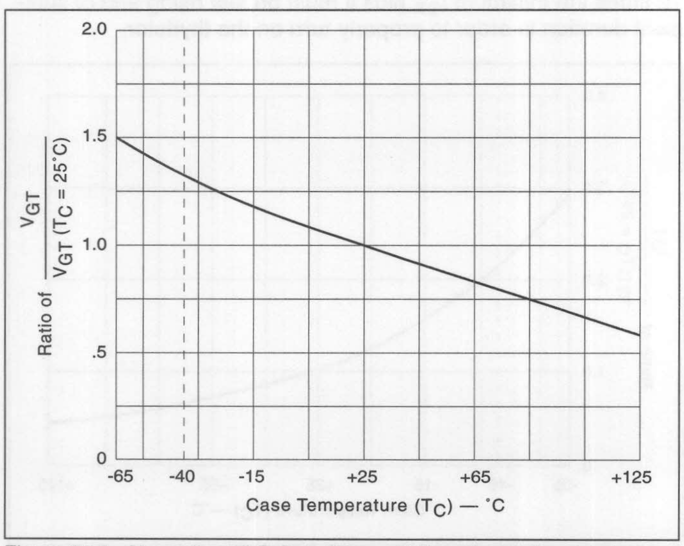


Figure 21.8 Normalized DC Gate Trigger Voltage for all Quadrants vs Case Temperature

I_L: Latching Current

SCR: Latching current is the DC anode current above which the gate signal can be withdrawn and the device will stay on. It is related to, has the same temperature dependence as, and is somewhat greater than the DC gate trigger current (see Figures 21.1 and 21.2). Latching current is at least equal to or much greater than the holding current depending on the thyristor type.

Latching current is greater for fast-rise-time anode currents since not all of the chip/die is in conduction. It is this "dynamic" latching current that determines whether a device will stay on when the gate signal is replaced with very short gate pulses. The dynamic latching current varies with the magnitude of the gate drive current and pulse duration. In some circuits, the anode current may oscillate and may drop back below the holding level or may even go negative; hence, the unit may turn off and not latch if the gate signal is removed too quickly.

Triac: The description of this characteristic is the same for the triac as for the SCR with addition that the triac can be latched on in four possible modes (quadrants). Also, the required latching is significantly different depending on which gating quadrants are used. Figure 21.9 illustrates typical latching current requirements for the four possible quadrants of operation.

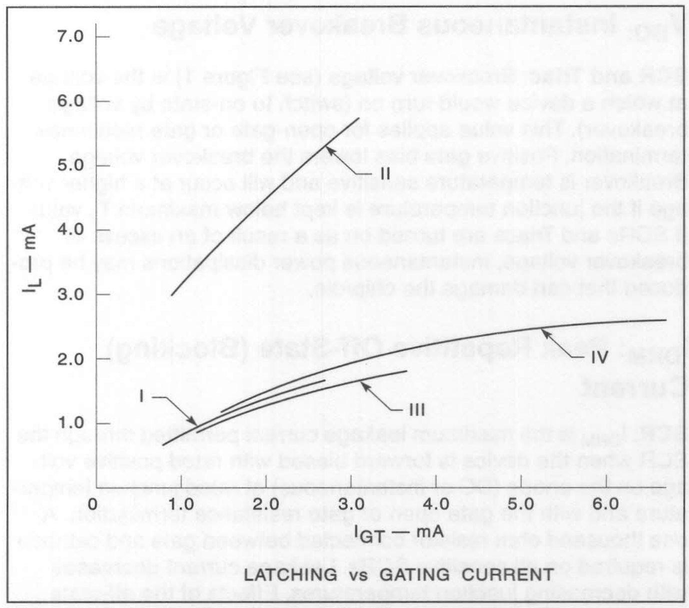


Figure 21.9 Typical Triac Latching (I_L) Requirements for Four Quadrants vs I_{GT}

I_H: Holding Current

SCR and Triac: The holding current is the DC principal on-state current below which the device will not stay in regeneration/on-state after latching and gate signal is removed. This current is equal to or lower in value than the latching current (see Figures 21.1 and 21.2) and is related to and has the same temperature dependence as the DC gate trigger current (see Figure 21.10). Both minimum and maximum holding current may be important. If the device is to stay in conduction at low anode currents, the maximum holding current of a device for a given circuit must be considered. The minimum holding current of a device must be considered if the device is expected to turn off at a low DC anode current. Note that the low DC principal current condition is a DC turn-off mode, and that an initial on-state current (latching cur-

rent) is required to ensure that the thyristor has been fully turned on prior to a holding current measurement.

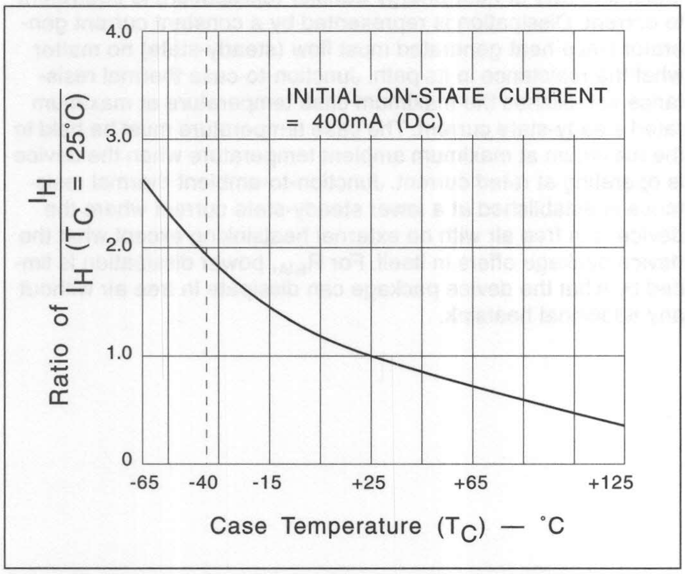


Figure 21.10 Normalized DC Holding Current vs Case Temperature

dv/dt, Static: Critical Rate-of-Rise of Off-State Voltage

SCR and Triac: Static dv/dt (see Figure 21.11 for exponential definition) is the minimum rate-of-rise of off-state voltage that a device will hold-off, with gate open, without turning on. This value will be reduced by a positive gate signal. This characteristic is temperature dependent and is lowest at the maximum-rated junction temperature. Therefore, the characteristic is determined at rated junction temperature and at rated forward off-state voltage which is also a worst-case situation. Line or other transients which might be applied to the thyristor in the off state must be reduced, so that neither the rate-of-rise nor the peak voltage are above specifications if false firing is to be prevented. Turn on as result of dv/dt is non-destructive as long as the follow current remains within current ratings of device being used.

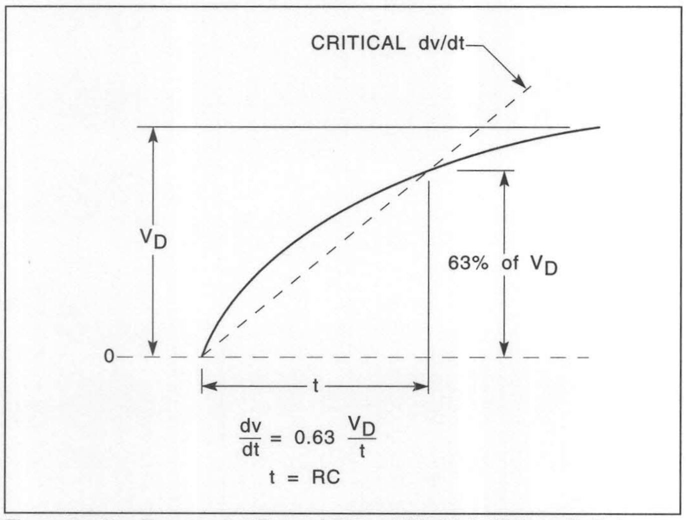


Figure 21.11 Exponential Rate-of-Rise of Off-State Voltage Defining dv/dt

dv/dt, Commutating: Critical Rate-of-Rise of Commutation Voltage

Triac: Commutating dv/dt is the rate-of-rise of voltage across the main terminals that a triac can support (block without switching back on) when commutating from the on-state in one half-cycle to the off-state in the opposite half-cycle. This parameter is specified at maximum rated case (equaled to T_J) temperature since it is temperature dependent. It is also dependent on current (commutating di/dt) and peak reapplied voltage (line voltage) and is specified at rated current and voltage. All devices are guaranteed to commutate rated current with a resistive load at 50 to 60 Hz. Commutation of rated current is not guaranteed at higher frequencies, and no direct relationship can be made with regard to current/temperature derating for higher-frequency operation.

With inductive loading, when the voltage is out of phase with the load current, there will be a voltage stress (dv/dt) across the main terminals of the triac during the zero-current crossing (see Figure 21.12). A snubber (series RC across the triac) should be used with inductive loads to decrease the applied dv/dt to an amount below the minimum value which the triac can be guaranteed to commutate off each half-cycle.

Commutating dv/dt is specified for a half sinewave current at 60 Hz which fixes the di/dt of the commutating current. The commutating di/dt for 50 Hz is approximately 20 percent lower and for the same I_{RMS} (see Figure 21.4).

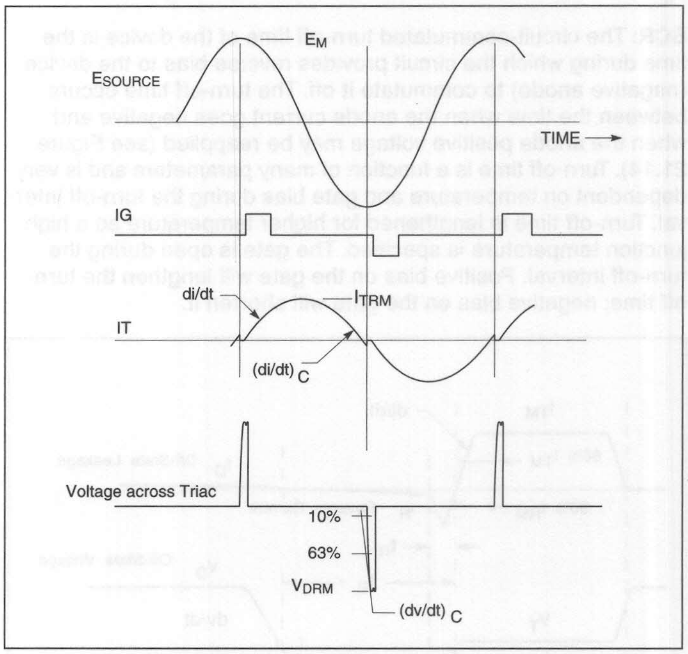


Figure 21.12 Waveshapes of Commutating dv/dt and Associated Conditions

t_{gt}: Gate Controlled Turn-On Time

SCR and Triac: The t_{gt} is the time interval between the application of a gate pulse and the on-state current reaching 90 percent of its steady-state value (see Figure 21.13). Turn-on time is a function of gate drive as would be expected. Shorter turn-on times occur for increased gate drives. This turn-on time is actually only valid for resistive loading. For example, inductive loading would restrict the rate-of-rise of anode current. For this reason, this parameter does not indicate the time which must be allowed for the device to stay on if the gate signal is removed (refer to the description of latching current I_L). However, if the

load were resistive and equal to the rated load current value, the device definitely would be operating at a current above the dynamic latching current in the turn-on time interval since current through the device is at 90 percent of its peak value during this interval.

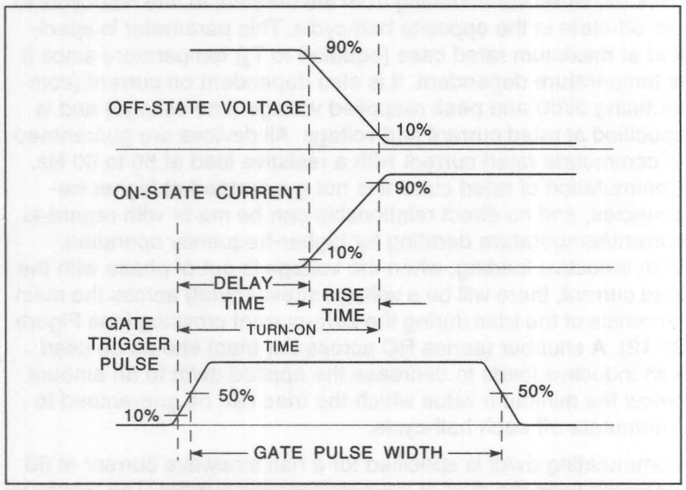


Figure 21.13 Waveshapes for Turn-On Time and Associated Conditions

t_q: Circuit - Commutated Turn-Off Time

SCR: The circuit-commutated turn-off time of the device is the time during which the circuit provides reverse bias to the device (negative anode) to commutate it off. The turn-off time occurs between the time when the anode current goes negative and when the anode positive voltage may be reapplied (see Figure 21.14). Turn-off time is a function of many parameters and is very dependent on temperature and gate bias during the turn-off interval. Turn-off time is lengthened for higher temperature so a high junction temperature is specified. The gate is open during the turn-off interval. Positive bias on the gate will lengthen the turn-off time; negative bias on the gate will shorten it.

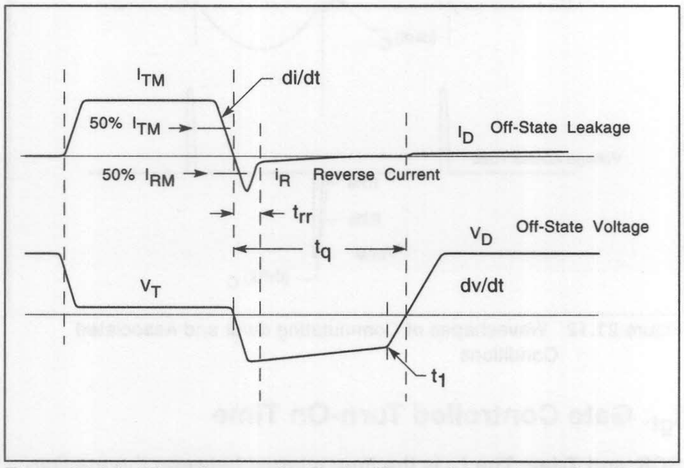


Figure 21.14 Waveshapes of t_q Rating Test and Associated Conditions

$R_{\theta JC}$, $R_{\theta JA}$: Thermal Resistance (Junction-to-Case, Junction-to-Ambient)

SCR and Triac: The thermal-resistance characteristic defines the steady-state temperature difference between two points at a given rate of heat-energy transfer (dissipation) between the points. The thermal-resistance system is an analog to an electrical circuit where thermal resistance is equivalent to electrical resistance, temperature difference is equivalent to voltage difference, and rate of heat-energy transfer (dissipation) is equivalent to current. Dissipation is represented by a constant current generator since heat generated must flow (steady-state) no matter what the resistance in its path. Junction-to-case thermal resistance establishes the maximum case temperature at maximum rated steady-state current. The case temperature must be held to the maximum at maximum ambient temperature when the device is operating at rated current. Junction-to-ambient thermal resistance is established at a lower steady-state current where the device is in free air with no external heatsinking except what the device package offers in itself. For $R_{\theta JA}$, power dissipation is limited by what the device package can dissipate in free air without any additional heatsink.

Miscellaneous Design Tips and Facts

Example 1: Characteristics Formulas for Phase Control Circuits

Circuit Name	Max Thyristor Voltage	PRV SCR	Max. Load Voltage E_d=Avg. E_a=RMS	Load Voltage with Delayed Firing	Max. Average Thyristor or Rectifier Current: Avg. Amps	Max. Average Thyristor or Rectifier Current: Cond. Period
Half-Wave Resistive Load	1.4 E_{RMS}	E_p	$E_d = \frac{E_p}{\pi}$ $E_a = \frac{E_p}{2}$	$E_d = \frac{E_p}{2\pi}(1 + \cos\alpha)$ $E_a = \frac{E_p}{2\sqrt{\pi}}\sqrt{\left(\pi - \alpha + \frac{1}{2}\sin 2\alpha\right)}$	$\frac{E_p}{\pi R}$	180
Full-Wave Bridge	1.4 E_{RMS}	Ep	$E_d = \frac{2E_p}{\pi}$	$E_d = \frac{E_p}{2\sqrt{\pi}}(1 + \cos\alpha)$	$\frac{E_p}{\pi R}$	180
Full-Wave AC Switch Resistive Load	1.4 E_{RMS}	Ep	$E_a = \frac{E_p}{1.4}$	$E_a = \frac{E_p}{\sqrt{2\pi}}\sqrt{\left(\pi - a\alpha + \frac{1}{2}\sin 2\alpha\right)}$	$\frac{E_p}{\pi R}$	180

Note: Angle a is in radians.

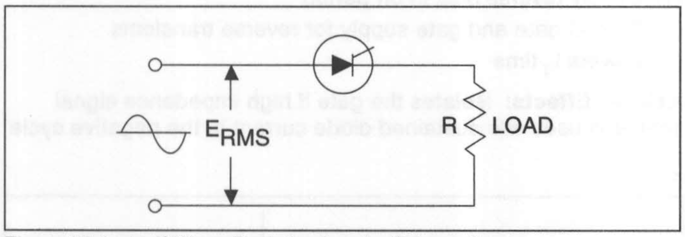


Figure 22.1 Half-Wave Resistive Load – Schematic

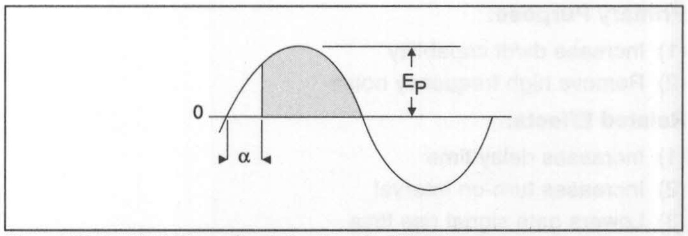


Figure 22.4 Half-Wave Resistive Load – Waveform

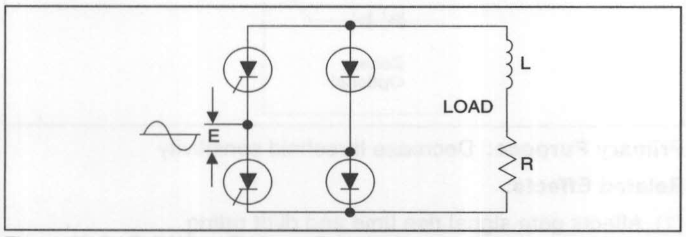


Figure 22.2 Full-Wave Bridge – Schematic

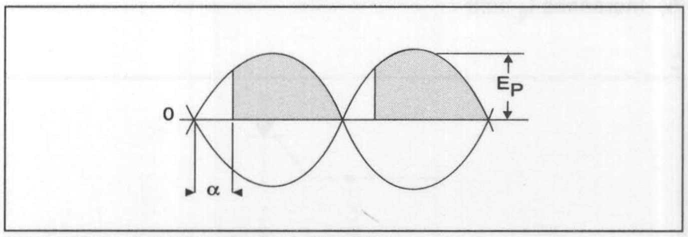


Figure 22.5 Full-Wave Bridge – Waveform

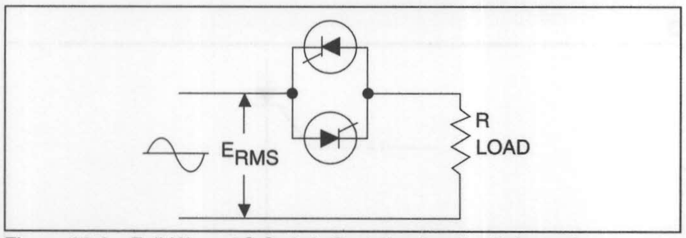


Figure 22.3 Full-Wave AC Switch Resistive Load – Schematic

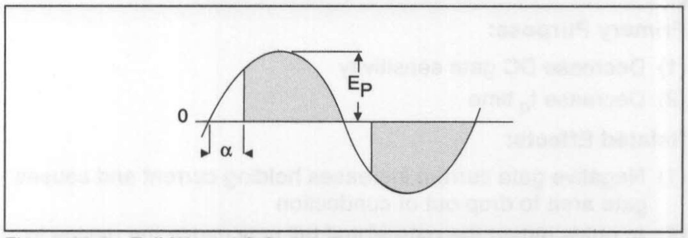
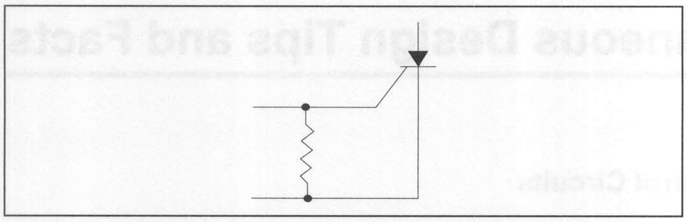


Figure 22.6 Full-Wave AC Switch Resistive Load – Waveform

Example 2: Pros and Cons of Gate Termination

A



Primary Purpose:

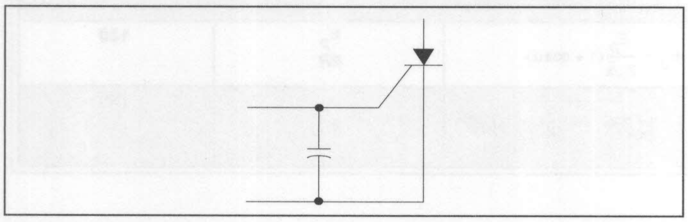
(1) Increase dv/dt capability

(2) Keep gate clamped to assure V_{DRM} capability

(3) Lowers t_q time

Related Effects: Raises the device latching and holding current

B



Primary Purpose:

(1) Increase dv/dt capability

(2) Remove high frequency noise

Related Effects:

(1) Increases delay time

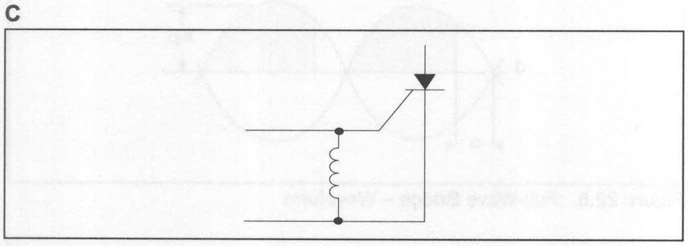
(2) Increases turn-on interval

(3) Lowers gate signal rise time

(4) Lowers di/dt capability

(5) Increases t_q time

C



Primary Purpose:

(1) Decrease DC gate sensitivity

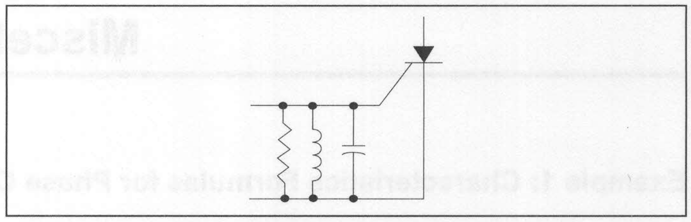
(2) Decrease t_q time

Related Effects:

(1) Negative gate current increases holding current and causes gate area to drop out of conduction

(2) In pulse gating the gate signal tail may cause the device to drop out of conduction

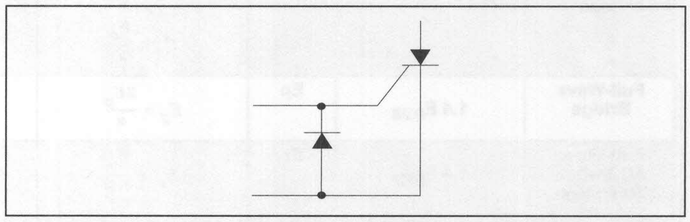
D



Primary Purpose: Frequency selection

Related Effects: Unless circuit is "damped" the positive and negative gate current may inhibit conduction or bring about sporadic anode current

E



Primary Purpose:

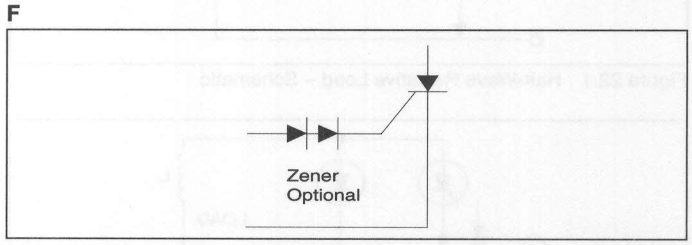
(1) Supply reverse bias in off period

(2) Protect gate and gate supply for reverse transients

(3) Lowers t_q time

Related Effects: Isolates the gate if high impedance signal source is used w/o sustained diode current in the negative cycle

F



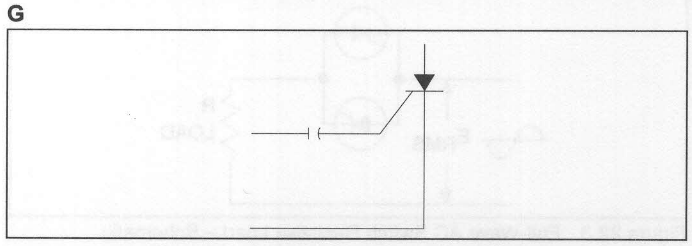
Primary Purpose: Decrease threshold sensitivity

Related Effects:

(1) Affects gate signal rise time and di/dt rating

(2) Isolates the gate

G



Primary Purpose: Isolate gate circuit DC component

Related Effects: In narrow gate pulses and low impedance sources the Igt is followed by reverse gate signals which may inhibit conduction

Example 3: Relationship of I_{AV}, I_{RMS}, and I_{PK}

Since a single rectifier or SCR passes current in one direction only, it conducts for only half of each cycle of an AC sinewave. The average current (I_{AV}) then becomes half of the value determined for full-cycle conduction, and the RMS current (I_{RMS}) is equal to the square root of half the mean-square value for full-cycle conduction or half the peak current (I_{PK}). In terms of half-cycle sinewave conduction (as in a single-phase half-wave circuit), the relationships of the rectifier currents can be shown as follows:

$$I_{PK} = \pi\ I_{AV} = 3.14\ I_{AV}$$
$$I_{AV} = (1/\pi)\ I_{PK} = 0.32\ I_{PK}$$
$$I_{PK} = 2\ I_{RMS}$$
$$I_{RMS} = 0.5\ I_{PK}$$
$$I_{AV} = (2/\pi)\ I_{RMS} = 0.64\ I_{RMS}$$
$$I_{RMS} = (\pi/2)\ I_{AV} = 1.57\ I_{AV}$$

When two identically rated SCRs are connected inverse parallel for full-wave operation (see Figure A), they can handle 1.41 times the RMS current rating of either single SCR. Therefore, the RMS value of two half sinewave current pulses in one cycle is √2 times the RMS value of one such pulse per cycle.

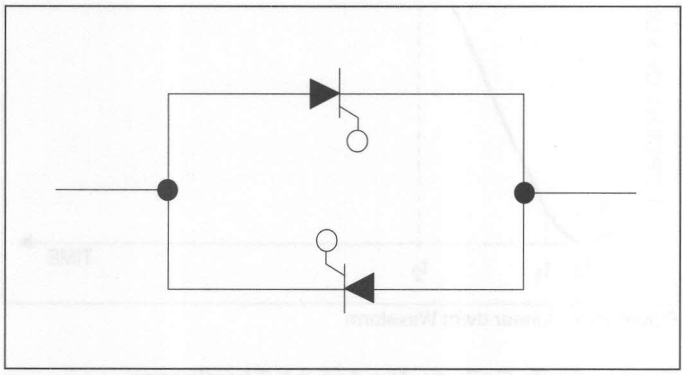


Figure 23.1 SCR Anti-Parallel Circuit

Example 4: Curves for Average Current at Various Conduction Angles

SCR maximum average current curves for various conduction angles can be established using the factors given below. Note maximum allowable case temperature (T_C) remains the same for each conduction angle curve but is established from average current rating at 180∞ conduction as given in data sheet for a particular device type. The maximum T_C curve is then derated down to the maximum junction (T_J). The illustration shown is derated to 125°C since the maximum T_J for the non-sensitive SCR series is 125°C.

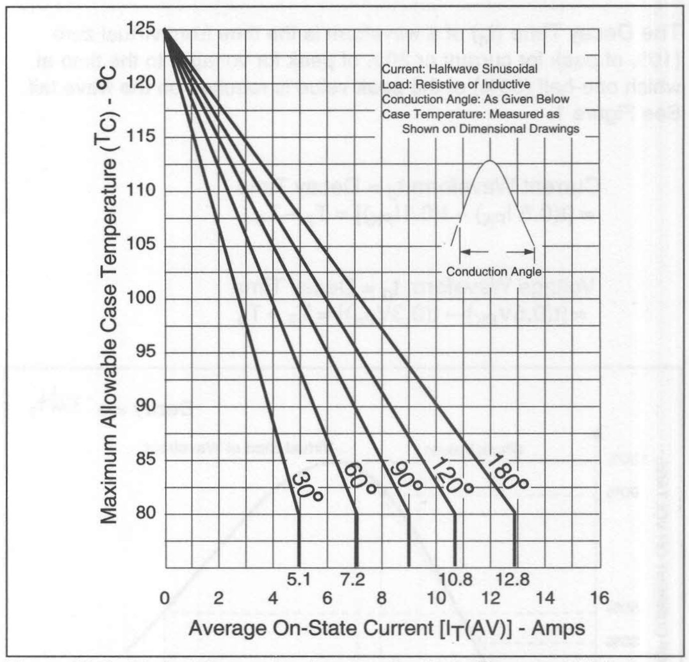


Figure 23.2 Typical Curves for Average On-State Current at Various Conduction Angles vs. T_C for a SXX20L SCR.

Factors for maximum average current at conduction angle of:

30° = .40 x Avg 180°
60° = .56 x Avg 180°
90° = .70 x Avg 180°
120° = .84 x Avg 180°

The reason for different ratings is the average current for conduction angles less than 180° is derated because of the higher RMS current connected with high peak currents.

Example 5: Double Exponential Impulse Waveform

A Double-Exponential Impulsewaveform or waveshape of current or voltage is designated by a combination of two numbers (t_r/t_d or $t_r \times t_d$ µSeconds). The first number is an exponential rise time (t_r) or wave front and the second number is an exponential decay time (t_d) or wave tail. The rise time (t_r) is the maximum rise time permitted. The decay time (t_d) is the minimum time permitted. Both the t_r and the t_d are in the same units of time, typically µSeconds, designated at the end of the waveform description as defined by ANSI/IEEE C62.1-1989.

The Rise Time (t_r) of a *current waveform* is, 1.25 times the time for the current to increase from 10% to 90% of peak value. See Figure 1.

$$t_r = \text{Rise Time} = 1.25 \bullet [t_c - t_a]$$
$$t_r = 1.25 \bullet [t(0.9\ I_{PK}) - t(0.1\ I_{PK})]\ T_1 - T_0$$

The Rise Time (t_r) of a *voltage waveform* is, 1.67 times the time for the voltage to increase from 30% to 90% of peak value. See Figure 1.

$$t_r = \text{Rise Time} = 1.67 \bullet [t_c - t_b]$$
$$t_r = 1.67 \bullet [t(0.9\ V_{PK}) - t(0.3 V_{PK})] = T_1 - T_0$$

The Decay Time (t_d) of a waveform is the time from virtual zero (10% of peak for current or 30% of peak for voltage) to the time at which one-half (50%) of the peak value is reached on the wave tail. See Figure 1.

Current Waveform t_d = Decay Time
$= [t(0.5\,I_{PK}) - t(0.1 I_{PK})] = T_2 - T_0$

Voltage Waveform t_d = Decay Time
$= [t(0.5V_{PK}) - t(0.3V_{PK})] = T_2 - T_0$

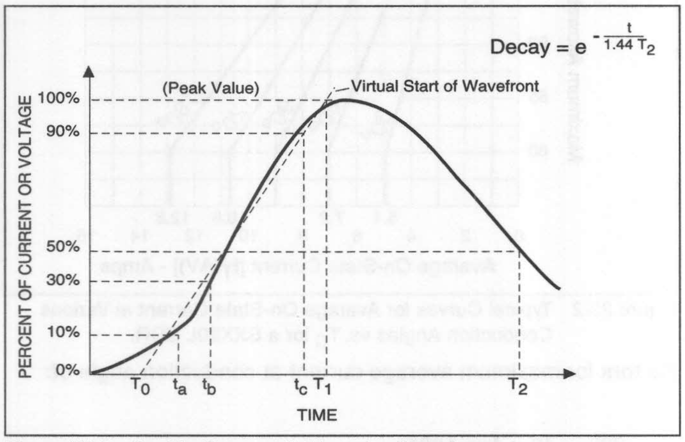


Figure 23.3 Double-Exponential Impulse Waveform

Example 6: dv/dt Definitions

Exponential dv/dt: The Rate-of-Rise of voltage (dv/dt) of an exponential waveform is 63% of peak voltage (excluding any overshoots) divided by the time at 63% minus 10% peak voltage. See Figure 2.

$$\text{Exponential dv/dt} = 0.63 \bullet \frac{[\text{ Vpeak }]}{(t_2 - t_1)}$$

Resistor Capacitor circuit $t = RC = (t_2 - t_1)$
Resistor Capacitor circuit $4 \bullet RC = (t_3 - t_2)$

Linear dv/dt: The Rate-of-Rise of voltage (dv/dt) of a linear waveform is 80% of peak voltage (excluding any overshoots) divided by the time at 90% minus 10% peak voltage. See Figure 3.

$$\text{Linear dv/dt} = 0.80 \bullet \frac{[\text{ Vpeak }]}{(t_2 - t_1)}$$

$$\text{Linear dv/dt} = \frac{[0.9 \text{ Vpeak} - 0.1 \text{ Vpeak}]}{(t_2 - t_1)}$$

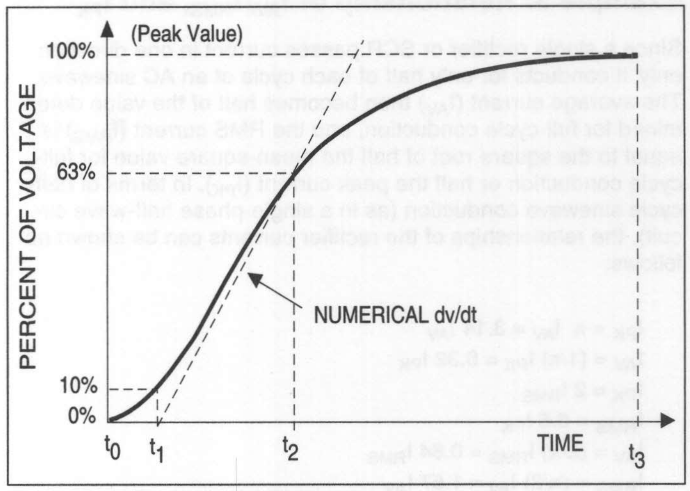


Figure 23.4 Exponential dv/dt Waveform

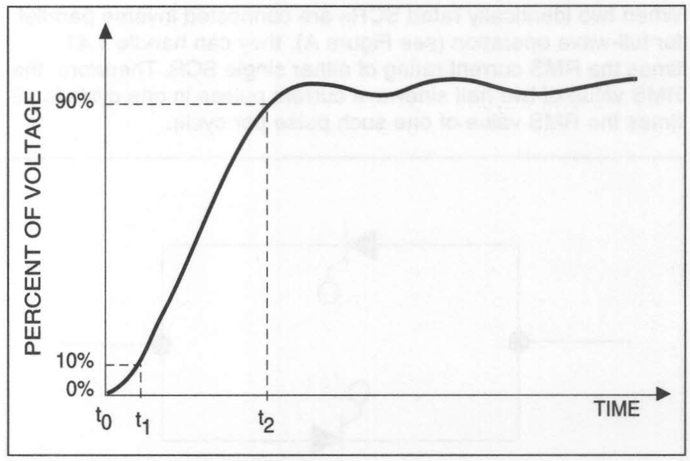


Figure 23.5 Linear dv/dt Waveform

Example 7: Failure Modes of Thyristor

Thyristor failures may be broadly classified as either degrading or catastrophic. A degrading type of failure is defined as a change in some characteristic which may or may not cause a catastrophic failure, but could show up as a latent failure. Catastrophic failure is when a device exhibits a sudden change in characteristic that renders it inoperable. To minimize degrading and catastrophic failures, devices must be operated within maximum ratings at all times.

Degradation Failures

A significant change of on-state, gate, or switching characteristics is quite rare. The most vulnerable characteristic is blocking voltage. This type of degradation increases with rising operating voltage and temperature levels.

Catastrophic Failures

A catastrophic failure can occur whenever the thyristor is operated beyond its published ratings. The most common failure mode is an electrical short between the main terminals, although a triac can fail in a half wave condition. It is possible, but not probable, that the resulting short circuit current could melt the internal parts of the device which could result in an open circuit.

Failure Causes

Most thyristor failures occur due to exceeding the maximum operating ratings of the device. Over voltage or over current operations are the most probable cause for failure. Over voltage failures may be due to excessive voltage transients or may also occur if inadequate cooling allows the operating temperature to rise above the maximum allowable junction temperature. Over current failures are generally caused by improper fusing or circuit protection, surge current from load initiation, load abuse, or load failure. Another common cause of device failure is incorrect handling procedures used in the manufacturing process. Mechanical damage in the form of excessive mounting torque and/or force applied to the terminals or leads can transmit stresses to the internal thyristor chip and cause cracks in the chip which may not show up until the device is thermally cycled.

Prevention of Failures

Careful selection of the correct device for the application's operating parameters and environment will go a long way toward extending the operating life of the thyristor. Good design practice should also limit the maximum current through the main terminals to 75% of the device rating. Correct mounting and forming of the leads also help ensure against infant mortality and latent failures. The two best ways to ensure long life of a thyristor is by proper heat sink methods and correct voltage rating selection for worst case conditions. Overheating, over voltage, and surge currents are the main killers of semiconductors.

Most Common Thyristor Failure Mode

When a thyristor is electrically or physically abused and fails either by degradation or a catastrophic means, it will short (full wave or half wave) as its normal failure mode. Rarely does it fail open circuit. The circuit designer should add line breaks, fuses, over temperature interrupters or whatever is necessary to protect the end user and property if a shorted or partially shorted thyristor offers a safety hazard.

Notes

TECCOR ELECTRONICS, INC.

Standard Terms and Condition

Supplier shall not be bound by any term proposed by Buyer in the absence of written agreement to such term signed by an authorized officer of Supplier.

(1) PRICE:

(A) Supplier reserves the right to change product prices at any time but, whenever practicable, Supplier will give Buyer at least thirty (30) days written notice before the effective date of any price change. Unless Supplier has specifically agreed in writing, signed by an authorized officer of Supplier, that a quoted price shall not be subject to change for a certain time, all products shipped on or after the effective date of a price change may be billed at the new price level.

(B) Whenever Supplier agrees to a modification of Buyer's order (which modification must be in writing and signed by an authorized officer of Supplier), Supplier reserves the right to alter its price, whether or not such price was quoted as "firm."

(C) Prices do not include federal, state or local taxes, now or hereafter enacted, applicable to the goods sold. Taxes will be added by Supplier to the sales prices whenever Supplier has legal obligation to collect them and will be paid by Buyer as invoiced unless Buyer provides Supplier with a proper tax exemption certificate.

(2) PRODUCTION: Supplier may, at its sole discretion and at any time, withdraw any catalog item from further production without notice or liability to Buyer.

(3) INTEREST:

(A) All late payments shall bear interest thirty (30) days after the due date stated on the invoice until paid at the lower of one and one-half percent per month or the maximum rate permitted by law. All interest becoming due shall, if not paid when due, be added to principal and bear interest from the due date. At Supplier's option, any payment shall be applied first to interest and then to principal.

(B) It is the intention of the parties to comply with the laws of the jurisdiction governing any agreement between the parties relating to interest. If any construction of the agreement between the parties indicates a different right given to Supplier to demand or receive any sum greater than that permissible by law as interest, such as a mistake in calculation or wording, this paragraph shall override. In any contingency which will cause the interest paid or agreed to be paid to exceed the maximum rate permitted by law, such excess will be applied to the reduction of any principal amount due, or if there is no principal amount due, shall be refunded.

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(5) CONTINGENCIES: Supplier shall not be responsible for any failure to perform due to causes reasonably beyond its control. These causes shall include, but not be restricted to, fire, storm, flood, earthquake, explosion, accident, acts of public enemy, war rebellion, insurrection, sabotage, epidemic, quarantine restrictions, labor disputes, labor shortages, labor slow downs and sit downs, transportation embargoes, failure or delays in transportation, inability to secure raw materials or machinery for the manufacture of its devices, acts of God, acts of the Federal Government or any agency thereof, acts of any state or local government or agency thereof, and judicial action. Similar causes shall excuse Buyer for failure to take goods ordered by Buyer, from the time Supplier receives written notice from Buyer and for as long as the disabling cause continues, other than for goods already in transit or specially fabricated and not readily saleable to other buyers.

Supplier assumes no responsibility for any tools, dies, and other equipment furnished Supplier by Buyer.

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SUPPLIER'S ENTIRE LIABILITY AND BUYER'S EXCLUSIVE REMEDY UNDER THIS WARRANTY SHALL BE, AT SUPPLIER'S OPTION, EITHER THE REPLACEMENT OF, REPAIR OF, OR ISSUANCE OF CREDIT TO BUYER'S ACCOUNT WITH SUPPLIER FOR ANY PRODUCTS WHICH ARE PROPERLY RETURNED BY BUYER DURING THE WARRANTY PERIOD. All returns must comply with the following conditions:

(A) Supplier is to be promptly notified in writing upon discovery of defects by Buyer.
(B) Buyer must obtain a Return Material Authorization (RMA) number from the Supplier prior to returning product.
(C) The defective product is returned to Supplier, transportation charges prepaid by Buyer.
(D) Supplier's examination of such product discloses, to its satisfaction, that such defects have not been caused by misuse, neglect, improper installation, repair, alteration, or accident.
(E) The product is returned in the form it was delivered with any necessary disassembly carried out by Buyer at Buyer's expense.

IN NO EVENT SHALL SUPPLIER, OR ANYONE ELSE ASSOCIATED IN THE CREATION OF ANY OF SUPPLIER'S PRODUCTS OR SERVICES, BE LIABLE TO BUYER FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE INCLUDING LOSS OF PROFITS, LOSS OF USE, BUSINESS INTERUPTION, AND THE LIKE. BUYER ACKNOWLEDGES THAT THE ABOVE WARRANTIES AND LIMITATIONS THEREON ARE APPROPRIATE AND REASONABLE IN EFFECTUATING SUPPLIER'S AND BUYER'S MUTUAL INTENTION TO CONDUCT AN EFFICIENT TRANSACTION AT PRICES MORE ADVANTAGEOUS TO BUYER THAN WOULD BE AVAILABLE IN THE PRESENCE OF OTHER WARRANTIES AND ASSURANCES.

(7) PATENTS: Buyer shall notify Supplier in writing of any claim that any product or any part of use thereof furnished under this agreement constitutes an infringement of any U.S. patent, copyright, trade secret, or other proprietary rights of a third party. Notice shall be given within a reasonable period of time which should in most cases be within ten (10) days of receipt by Buyer of any letter, summons, or complaint pertaining to such a claim. At its option, Supplier may defend at its expense any action brought against Buyer to the extent that it is based on such a claim. Should Supplier choose to defend any such claim, Supplier may fully participate in the defense, settlement, or appeal of any action based on such claim.

Should any product become, or in Supplier's opinion be likely to become, the subject of an action based on any such claim, Supplier may, at its option, as the Buyer's exclusive remedy, either procure for the Buyer the right to continue using the product, replace the product or modify the product to make it noninfringing. IN NO EVENT SHALL SUPPLIER BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES BASED ON ANY CLAIM OF INFRINGEMENT.

Supplier shall have no liability for any claim based on modifications of a product made by any person or entity other than Supplier, or based on use of a product in conjunction with any other item, unless expressly approved by Supplier. Supplier does not warrant goods against claims of infringement which are assembled, prepared, or manufactured to Buyer's specifications.

(8) NON-WAIVER OF DEFAULT: Each shipment made under any order shall be treated as a separate transaction, but in the event of any default by Buyer, Supplier may decline to make further shipments without in any way affecting its rights under such order. If, despite any default by Buyer, Supplier elects to continue to make shipments, its action shall not constitute a waiver of that or any default by Buyer or in any way affect Supplier's legal remedies for any such default. At any time, Supplier's failure to exercise any right to remedy available to it shall not constitute a waiver of that right or remedy.

(9) TERMINATION: If the products to be furnished under this order are to be used in the performance of a Government contract or subcontract, and the Government terminates such contract in whole or part, this order may be canceled to the extent it was to be used in the canceled portion of said Government contract and the liability of Buyer for termination allowances shall be determined by the then applicable regulations of the Government regarding termination of contracts. Supplier may cancel any unfilled orders unless Buyer shall, upon written notice, immediately pay for all goods delivered or shall pay in advance for all goods ordered but not delivered, or both, at Supplier's option.

(10) LAW: The validity, performance and construction of these terms and conditions and any sale made hereunder shall be governed by the laws of the state of Texas.

(11) ASSIGNS: This agreement shall not be assignable by either Supplier or Buyer. However, should either Supplier or Buyer be sold or transferred in its entirety and as an ongoing business, or should Supplier or Buyer sell or transfer in its entirety and as an ongoing concern, any division, department, or subsidiary responsible in whole or in part for the performance of this Agreement, this Agreement shall be binding upon and inure to the benefit of those successors and assigns of Supplier, Buyer, or such division, department, or subsidiary.

(12) MODIFICATION OF STANDARD TERMS AND CONDITIONS: No attempted or suggested modification of or addition to any of the provisions upon the face or reverse of this form, whether contained or arising in correspondence and/or documents passing between Supplier and Buyer, in any course of dealing between Supplier or Buyer, or in any customary usage prevalent among businesses comparable to those of Supplier and/or Buyer, shall be binding upon Supplier unless made and agreed to in writing and signed by an officer of Supplier.

(13) QUANTITIES: Any variation in quantities of electronic components, or other goods shipped over or under the quantities ordered (not to exceed 5%) shall constitute compliance with Buyer's order and the unit price will continue to apply.

APPLICATION CHECKLIST FAX

To: TECCOR ELECTRONICS, Inc. FAX: 972 550-1309

FROM: ______________________________ Title: ________________ Phone: __________ Ext: _____

FAX: __________

Company: ____

Address: ____

City: ____________________ State/Province: __________ Country: __________ Zip/PC: __________

1) LOAD TYPE YOU NEED TO CONTROL

( ) Resistive ( ) Inductive ( ) Capacitive

( ) Heater ( ) Motor

( ) Lamps ( ) Solenoid

( ) Transformer

2) CURRENT THROUGH LOAD/DEVICE

____ Amps RMS ____ Amps Average or Pulsed ____ Amps Peak for ____ duration and _____ rep rate

3) VOLTAGE TO BE CONTROLLED

( ) 120VAC, 50 or 60 Hz ( ) 240VAC, 50 or 60 Hz ( ) Other ______ VAC ____ Hz

( ) 1/2 Wave D.C. ____ Hz ( ) Full wave D.C. ____ Hz ( ) D.C. ______ Volts

4) TYPE OF CONTROL NEEDED

( ) On - Off ( ) Variable voltage output

( ) Random ( ) Phase Control

( ) 0V Crossing

5) CIRCUIT BEING USED TO TURN ON THYRISTOR

( ) Analog ( ) Digital

( ) Phase Control, simple R/C ( ) P

( ) Other ____________________ ( ) I.C. - which one __________

( ) Crowbar application Available drive current ____ Sink ____ Source

( ) Sensing device ______

( ) May have common electrical node with output voltage

( ) Must be electrically isolated from output voltage

Type of isolation device used
( ) Optical Driver ( ) Pulse transformer ( ) Other __________

6) OPERATING TEMPERATURE

( ) Ambient from ____ºC to ____ºC

Teccor Electronics, Inc.
(972) 540-7777